Millwright

# Occupational Analysis Report

September 2013

Commission
de la construction
du Québec

The purpose of this report is to describe as accurately as possible the millwright trade as currently practiced in Québec's construction industry. It is a record of discussions held by a group of workers who met for the occasion after industry partners recommended them to the Commission de la construction du Québec for their expertise in the trade.

The occupational analysis is a first step in the definition of the competencies required for practicing the trade. This report becomes one of the reference and decision-making tools used by the Commission for teaching and learning purposes.

**This report does not bind the Commission in any way. It has no legal effect and is meant as a reflection of discussions held on the date of the analysis workshop.**


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The masculine gender is used generically in this document to facilitate reading.

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# APPROVAL

This occupational analysis report on the millwright trade was read and approved by Commission de la construction du Québec authorities and the following persons on the dates mentioned below:

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May 28, 2014

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# INTRODUCTION

In early 2009, the Direction de la formation professionnelle of the Commission de la construction du Québec (CCQ) launched a large-scale operation to review the occupational analyses[1] of all construction industry trades.

The CCQ undertook this operation for many reasons, particularly the following:

- the project to reform the construction workforce apprenticeship and management system, and the eventual design of qualitative apprenticeship logbooks requiring a detailed description of each trade;

- the fact that most construction occupational analyses [2] had been conducted between 1987 and 1991 and had not been reviewed since;

- updates to vocational qualification examination question banks;

- implementation of Chapter 7 of the Agreement on Internal Trade (AIT) and of the Québec-France Understanding on the Mutual Recognition of Professional Qualifications.

These factors demonstrate the necessity of updating the occupational analyses in order to obtain a current and complete profile of the various trades in Quebec.

The occupational analysis of the millwright trade belongs to this context[3]. Its purpose is to describe this trade as currently practiced by journeymen in the construction industry. This report was written in order to collate and organize the information gathered during the occupational analysis workshop held in Laval on April 17 and 18, 2013.

This analysis aims to draw a portrait of the trade (tasks and operations) and its working conditions, and to identify the skills and behaviours required. The report of the occupational analysis workshop is an accurate reflection of the consensus reached by a group of millwright workers. A special effort was made to include in this report all the data collected during the workshop and to ensure that the data accurately depict the realities of the trade analysed.

1. The terms “profession” and “trade” are considered synonymous.
2. Called “work situation analyses” at the time.
3. This occupational analysis was conducted according to the *Cadre de référence et instrumentation pour l’analyse d’une profession*, produced in 2007 by the ministère de l’Éducation, du Loisir et du Sport (Direction générale de la formation professionnelle et technique) and the Commission des partenaires du marché du travail, ministère de l’Emploi et de la Solidarité sociale.

# 1. GENERAL CHARACTERISTICS OF THE TRADE

## 1.1 DEFINITION OF THE TRADE

According to the Regulation respecting the vocational training of workforce in the construction industry (Schedule A, section 20), the term “millwright” means anyone who:

a) installs, repairs[4], sets, erects, dismantles and handles equipment, including equipment for bowling alleys; conveyors and permanently-installed equipment; automatic doors and accessories; adjustable floors used to support machinery;

b) makes templates for such machinery and equipment.

The participants agreed with this definition, which represents their functions sufficiently well.

## 1.2 JOB TITLES

On construction sites, the job title “millwright” is generally used, as well as the title “mechanic.” In this report, the title “millwright” will be used[5].

Millwrights are at times confused with workers in other trades, mainly because the job titles are similar. This is the case for heavy equipment mechanics, stationary equipment mechanics or elevator mechanics.

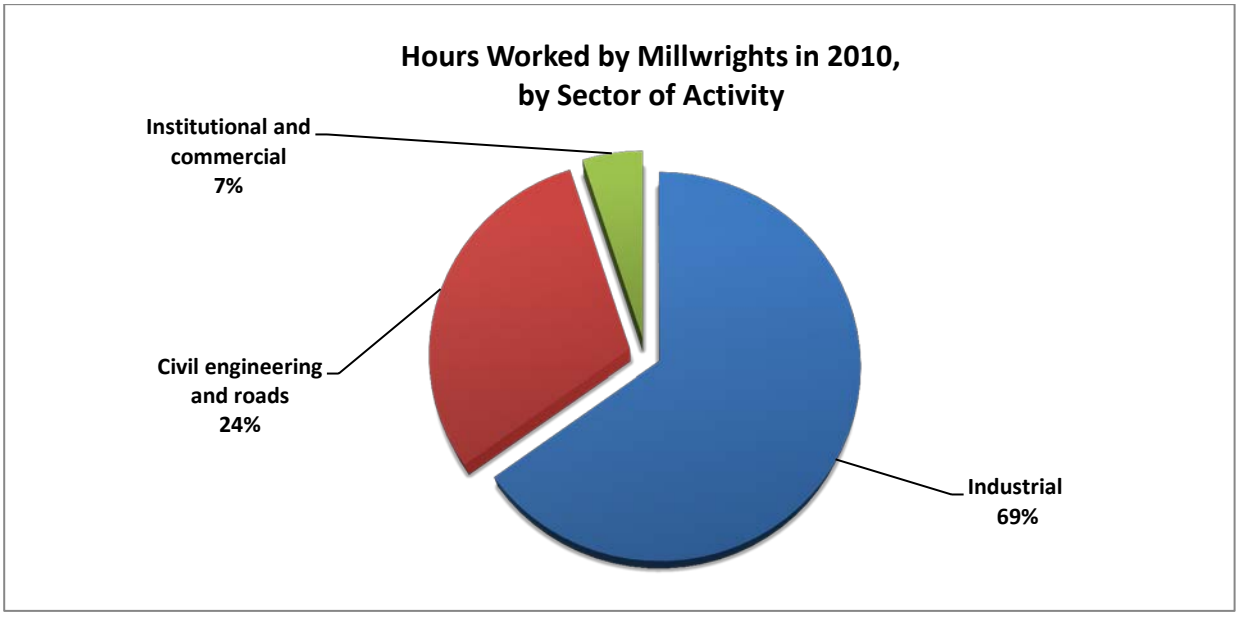
## 1.3 SECTORS OF ACTIVITY

Millwrights are active, to varying degrees, in three sectors of the construction industry:

- institutional and commercial;
- industrial;
- civil engineering and roads.

4. When installation, maintenance and repair work is done by construction employees on behalf of a professional employer, under section 1, paragraph 4 of the Statutory Regulation that work is subject to Act R-20.
5. This job title has been retained in order to avoid any confusion with other mechanics working on construction sites.

The graphic below illustrates the allocation of hours worked by all millwrights in Quebec in 2010[6].




After the above graphic was presented, we asked the participants to list the sectors where they have practiced their trade in the last year. The results appear in Table 1.1 below:

**Table 1.1 Working Hours Allocated by Sector of Activity**

| Sector | Working Hours Allocated by Sector (%) | |
|---|---|---|
| | All Millwrights in Quebec | Participants in the vocational analysis workshop |
| Institutional and commercial | 7% | 6% |
| Civil engineering and roads | 24% | 22% |
| Industrial | 69% | 72% |

It can be noted that, on average, the allocation of hours worked by the workshop participants is quite similar to that of all millwrights in Quebec.

Thus, the industrial sector provides slightly more than two-thirds of the hours worked by millwrights, whereas the civil engineering and roads sector provides slightly less than one-quarter.

6. Québec City. Commission de la construction du Québec (CCQ), *Careers - Construction*, 2011-2012 edition.

The participants pointed out that the work time allocation may vary considerably from year to year. For example, numerous millwrights have already begun working to install wind farms, and this trend is expected to rise. So in coming years, the percentage of time worked in the civil engineering and roads sector could increase significantly.

Moreover, the participants mentioned various industries where millwrights are likely to work. Some of those industries are:

- food (including bakeries, pastry shops, etc.);
- chemicals;
- pulp and paper;
- mining;
- commercial laundry;
- synthetic products (e.g.: polyester);
- textiles, carpets and similar products;
- flat or blown glass;
- etc.

## 1.4 FIELD OF PRACTICE

The trade's field of practice is the construction industry. The Act respecting labour relations, vocational training, and workforce management in the construction industry (R.S.Q., c. R-20) defines construction as follows:

> […] the foundation, erection, maintenance, renewal, repair, alteration and demolition work on buildings and civil engineering works carried out on the job site itself and vicinity including the previous preparatory work on the ground;
>
> In addition, the word "construction" includes the installation, repair and maintenance of machinery and equipment, work carried out in part on the job site itself and in part in the shop, moving of buildings, transportation of employees, dredging, turfing, cutting and pruning of trees and shrubs and laying out of golf courses, but solely in the cases determined by regulation.

## 1.5 LAWS AND REGULATIONS

Millwrights in the construction industry are subject to:

- the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20);
- the Regulation respecting the vocational training of workforce in the construction industry (R-20, r.6.2);
- the four sector-based collective agreements of the construction industry;
- the National Building Code – Canada 2005 (NBC);
- the Quebec Building Code, Chapter I, “Building”;
- the Act Respecting Occupational Health and Safety (R.S.Q., c. S-2.1);
- the Safety Code for the construction industry (R.Q. c. S-2.1, r.6);
- municipal by-laws, if applicable.

In addition, the participants mentioned that some companies add internal regulations, particularly regarding safety.

## 1.6 WORKING CONDITIONS

The following information provides an overview of the conditions and context of the work of millwrights, as commented by the participants in the occupational analysis workshop. To obtain up-to-date and complete information that has legal effect, it is necessary to refer to the four collective agreements of the construction industry sectors.

## Salary[7]

A journeyman millwright's daytime hourly wage is as follows (at May 1, 2011):

- Industrial: $34.01
- Institutional and commercial: $34.01
- Civil engineering and roads: $34.09
- Light residential: $31.91
- Heavy residential: $33.97

## Vacations and time off[8]

Mandatory annual holidays of four weeks – two weeks in summer and two in winter at fixed periods determined in collective agreements – are the general rule in the construction industry. To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow certain changes to these prescribed vacation periods. In addition to these vacation periods, employees receive eight statutory holidays and a lump sum for sick leave.

## Pension plan

Construction industry workers have access to a pension plan. They retain their eligibility for this pension plan throughout their career in construction, even if they change employer, trade or sector.

## Insurance

The group insurance plan (medications, illness, disability, death) is fully paid by employers. Workers (and their families, as the case may be) are eligible for it so long as they remain active in the construction industry and work the required number of hours, whether or not they change employer.

7. The salary data are excerpted from the document *Careers – Construction*, 2011-2012 edition, published by the la Commission de la construction du Québec, and from the collective agreements of the construction industry sectors.
8. Data on vacations and time off, pension plan and insurance are excerpted from the following document, published in 2009 by the Commission de la construction du Québec: *La construction au Québec: c'est bien plus payant!*.

**Physical requirements**

A millwright must be in sufficiently good physical condition and must be flexible, although certain work methods make the work less demanding. A millwright generally works on his knees, which is very difficult for his joints, and often works in uncomfortable positions and restricted spaces. In addition, some physical strength is necessary, because the trade requires lifting and moving relatively heavy loads, which may weigh over 50 kg.

**Work schedules**

A 40-hour work week from Monday to Friday is the general rule in all construction industry sectors. The daily limit is 8 hours a day, except in the light residential sector, where it can be up to 10 hours within a 40-hour week.

In the civil engineering and roads sector, the regular working hours of any employee are 40 hours a week from Monday to Friday, with a daily limit of 8 hours. However, in some cases, for example excavation and road work, the work week is 45 hours from Monday to Friday; the daily limit may then be either 9 hours from Monday to Friday, or 10 hours from Monday to Thursday and 5 hours on Friday.

To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow many possibilities for changing the schedule prescribed by the general rule: compressed schedule, schedule shift, etc. These special schedules confer flexibility to the work schedules in effect in the construction industry.

Depending on the sector in which they work, millwrights' work weeks are generally 40 hours from Monday to Friday. The participants mentioned that they may work in the evening, or even at night, and also on weekends. Overtime is not rare, particularly with tight deadlines, as is often the case. Indeed, since the machinery must be stopped for maintenance, repairs or modifications, millwrights' work schedules are often dictated by production stoppages, which companies want to be as short as possible. Moreover, for outdoor work, for example installing wind turbines, millwrights' work schedules largely depend on weather conditions.

Lastly, millwrights often have to work in other regions than those in which they reside. The majority of millwrights have already stayed in those regions for durations varying according to the work to be done. However, the participants stated that a millwright who would want to work only in his own region could still practice his trade, as long as he resides near large urban centres.

## 1.7 JOB MARKET ENTRY CONDITIONS

To obtain the competency certificate-apprentice in the trade, candidates must present to the CCQ the original version of an academic transcript or apprenticeship transcript attesting that they have passed a course of study leading to the DEP - Mécanique industrielle de construction et d'entretien, as well as a guarantee of employment from an employer registered with the CCQ for at least 150 hours within a period of not more than three consecutive months[9].

Although the construction industry favours graduates for access to the trade, labour shortages may at times make it necessary to give non-graduates access to the millwright trade. Thus, candidates without a diploma are eligible to obtain a competency certificate-apprentice only during a labour shortage and must[10]:

- supply proof that they have the academic prerequisites for the program leading to a DEP in the trade referred to in the application or pledge, by signing a consent letter, to take the necessary training to obtain those academic prerequisites;

- present, during a labour-pool opening, a guarantee of employment produced by an employer registered with the CCQ, for at least 150 hours over a period of at most three consecutive months.

The apprentice millwright must have completed three apprenticeship periods of 2,000 hours each (6,000 hours in total) in his trade, in order to be admitted to the provincial qualification examination, success in which leads to obtaining the competency certificate-journeyman for the trade. Training hours are credited in the apprenticeship record book of an apprentice millwright who has obtained his diploma.

9. Other conditions than those listed may apply. For a complete list of entry conditions for this trade, see the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20). The CCQ's website may also be consulted: http://www.ccq.org/en/DevenirTravailleur/E_CertificatsCompetence.
10. Ibid.

Among the millwrights who attended the meeting, 9 out of 10 took the training (DEP - Mécanique industrielle de construction et d'entretien or the equivalent).

Moreover, certain qualities are sought by employers hiring new millwrights. The following list presents the main qualities, in the order they were mentioned and not in order of importance:

- relevant experience and interest in the type of work to be done;
- positive attitude;
- interest in learning;
- teamwork ability;
- resourcefulness;
- adaptability;
- logical thinking, notably to solve mechanical problems;
- attention to detail.

The participants also emphasized the importance of professional ethics, which, in their view, is demonstrated by, among other things, dedication to work quality, rigour in performing the various tasks, the application of standards and requirements, and pride in practicing the trade.

## 1.8 PLACE OF WOMEN IN THE TRADE

Section 126.0.1 of the Act respecting labour relations, vocational training and workforce management in the construction industry pertains to women's access to the construction industry: "The Commission, after consultation with the Commission des droits de la personne et des droits de la jeunesse, shall develop measures to favour the access of women to and their maintenance and greater representation on the labour market in the construction industry."

According to the CCQ[11], 3 women were practicing the millwright trade in the construction industry in 2010 out of a total of 1,180 millwrights in 2010, i.e., 0.25%.

According to the participants, having to leave home for long periods is a factor that may discourage some women, particularly those who have or plan to have young children.

11. Commission de la construction du Québec, *Careers – Construction*, 2011-2012 edition.

However, the necessary physical strength to perform most of the tasks is reportedly the main obstacle to integrating women in the trade[12]. The experts consulted have difficulty imagining how a woman could perform all of the trade's tasks, which regularly require lifting heavy loads.

## 1.9 CAREER PROSPECTS

The career prospects of millwrights are similar to those of all construction workers. Thus, after a variable number of years of experience (depending on the context and persons), they may become team leaders, foremen, project managers, superintendents, etc. Entrepreneurship is less and less common among millwrights, because the investments required and the ever-more numerous standards to be met are deemed too demanding.

## 1.10 DEVELOPMENT OF THE TRADE

The main changes that have occurred in recent years and that, according to the participants, will likely remain or increase, are the following:

- Certain new types of work have appeared and occupy many millwrights, for example the installation of wind farms.
- In the industrial sector, the machinery is constantly evolving, which requires continual adaptation to new components, systems and accessories, work techniques, etc.
- During equipment installation, more and more components arrive pre-assembled; this means that less work needs to be done because less assembly is required, and that ever larger and heavier objects have to be lifted and moved. So rigging and lifting techniques must be adapted, and lifting plans are becoming more and more common.
- More and more often, manufacturers provide the workforce to install, maintain and repair the machinery they make, which reduces the quantity of work done by millwrights.
- New tools and instruments have appeared in the work of millwrights, notably laser levels, various types of scaffolds (e.g. hydraulic scaffolds) and access equipment (e.g. lifts), as well as, for some millwrights, transits and even total stations.

12. The participants nevertheless pointed out that the importance of physical strength varies depending on the construction sites and the types of work. In addition, certain work methods can reduce the necessary strength for practicing the trade.

## 1.11 IMPACT OF ENVIRONMENTAL STANDARDS ON THE PRACTICE OF THE TRADE

According to the participants, the work of millwrights has been changed by the arrival of certain environmental standards. In particular, the participants mentioned the elimination of waste oils and fluids and their containers, the prevention of spills, and the sorting of recyclable or reusable rejects.

Moreover, the application of certain environmental standards, particularly those related to toxic products, has induced many workers to consider the hazards to which they expose themselves when using those products, and to apply appropriate preventive measures.

# 2. WORK DESCRIPTION

## 2.1 TASKS AND OPERATIONS

### List of tasks

The following list was presented to the participants for validation purposes[13]; it presents the main tasks performed by millwrights. The order in which the tasks are presented does not necessarily reflect their importance in the trade.

| | |
|---|---|
| Task 1 | Install machinery |
| Task 2 | Do preventive maintenance on the machinery |
| Task 3 | Repair machinery |
| Task 4 | Modify machinery |

Millwrights perform their tasks on various types of machinery, such as:

- conveyors;
- pumps;
- compressors;
- presses;
- ovens (e.g.: steel works);
- crushers;
- stone crushers;
- centrifuges;
- production chains;
- overhead cranes;
- turbines;
- wind turbines;
- marine turbines;

13. In fact, the list presented to the participants contained a fifth task, titled « Rig and handle equipment." The participants considered this task included in the other ones, since it serves in their performance, so that it is not a task in itself.

- monorails;
- bottlers;
- etc.

**Table of tasks and operations**

During the workshop, a table of tasks and operations performed by millwrights was proposed to the participants[14]. Following discussions, changes were made to the table. The final version is presented in the following pages.

14. The table was prepared according to the *Devis de formation professionnelle : mécanicien de chantier*, produced by the Commission de la construction du Québec in 1989.

**Table 2.1 Tasks and Operations**

| TASKS | OPERATIONS | | | | | |
|---|---|---|---|---|---|---|
| **1. INSTALL MACHINERY** | 1.1 Find out about the work to be done | 1.2 Take safety measures | 1.3 Assess the work's feasibility | 1.4 Clear the work area | 1.5 Install scaffolds, if applicable | 1.6 Mobilize tools and equipment* |
| | 1.7 Plan the layout of the machinery to be installed | 1.8 Fabricate the necessary parts for the installation, if applicable | 1.9 Prepare the base to receive the machinery | 1.10 Put the machinery in place | 1.11 Rectify the machinery's position | 1.12 Apply grout between the concrete base and the machinery |
| | 1.13 Lubricate the machinery, if applicable | 1.14 Perform idling tests and rotations | 1.15 Perform pre-operational checks | 1.16 Check the installation during startup | 1.17 Make necessary corrections | 1.18 Complete the work |
| **2. DO PREVENTIVE MAINTENANCE ON THE MACHINERY** | 2.1 Find out about the work to be done | 2.2 Take safety measures | 2.3 Install scaffolds, if applicable | 2.4 Mobilize tools and equipment* | 2.5 Check the general condition of the production machinery | 2.6 Check the machinery's components |
| | 2.7 Detect anomalies and signs of wear | 2.8 Make minor corrections (adjust, regulate, etc.) | 2.9 Lubricate the machinery and restore fluid levels | 2.10 Check the operation during startup | 2.11 Complete the work | 2.12 Fill out a maintenance report |

*These are not machinery, but the tools and equipment that the millwright uses to perform the installation or maintenance (e.g.: crane, telescopic handler, etc.).

| TASKS | OPERATIONS | | | | | |
|---|---|---|---|---|---|---|
| **3. REPAIR MACHINERY** | 3.1 Find out about the work to be done | 3.2 Take safety measures | 3.3 Install scaffolds, if applicable | 3.4 Mobilize tools and equipment* | 3.5 Remove any damaged components | 3.6 Clear the work area |
| | 3.7 Check the layout of the machinery to be repaired and redo it if necessary | 3.8 Fabricate necessary parts for the repairs, if applicable | 3.9 Repair or replace the machinery's damaged components | 3.10 Put repaired components back in place | 3.11 Rectify the position of repaired components | 3.12 Apply grout between the concrete base and the machinery |
| | 3.13 Perform idling tests and rotations | 3.14 Check the repairs during startup | 3.15 Make necessary corrections | 3.16 Complete the work | | |
| **4. MODIFY MACHINERY** | 4.1 Find out about the work to be done | 4.2 Take safety measures | 4.3 Install scaffolds, if applicable | 4.4 Mobilize tools and equipment* | 4.5 Install a reference system | 4.6 Dismantle the machinery to be modified |
| | 4.7 Redo the layout of the machinery to be modified | 4.8 Modify components | 4.9 Fabricate the necessary parts for the modification, if applicable | 4.10 Prepare the base to receive the machinery | 4.11 Put the machinery in place | 4.12 Rectify the machinery's position |
| | 4.13 Apply grout between the concrete base and the machinery | 4.14 Check the machinery's torque | 4.15 Lubricate the machinery, if applicable | 4.16 Check the modification made | 4.17 Perform idling tests and rotations | 4.18 Check the modification during startup |
| | 4.19 Make necessary corrections | 4.20 Complete the work | | | | |

* These are not machinery, but the tools and equipment that the millwright uses to perform the repairs or modification.

## 2.2 OPERATIONS, SUB-OPERATIONS AND CLARIFICATIONS

Table 2.2 presents sub-operations associated to operations[15], as well as a few clarifications made by the participants for each of the millwright's tasks.

**Table 2.2 Sub-Operations and Operation Clarifications**

| TASK 1 INSTALL MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 1.1<br>Find out about the work to be done | 1.1.1 Read the plans<br>1.1.2 Read the work order<br>1.1.3 Receive the foreman's instructions | Generally, the foreman excerpts the part of the plans that pertains to the work to be done and gives the millwright a copy.<br>The participants mentioned that a trend is observed regarding instructions: in some companies, the millwright is handed a kit containing the plans, the description of work to be done, the list of steps to follow, the list of necessary tools, etc.<br>Generally, the millwright receives his foreman's guidelines. Exceptionally and for very little tasks, the millwright can receives guidelines directly from the client. |
| 1.2<br>Take safety measures | 1.2.1 Attend:<br>– the welcoming meeting on the construction site, if applicable<br>– your employer's welcoming meeting<br>– the meeting prior to superimposed work[16], if applicable<br>– various safety training<br>1.2.2 Learn about the permits, if applicable<br>1.2.3 Proceed with the lockout, if applicable<br>1.2.4 Establish a safety perimeter<br>1.2.5 Disconnect all power sources<br>1.2.6 Wear personal protective equipment<br>1.2.7 Participate in task safety analyses | Safety measures are now essential to the work of millwrights. At the start of major work, at least one full day is spent on examining work-related hazards and the preventive means to be adopted. In addition, a task safety analysis is performed each time millwrights change their work area, the machinery to be installed, the tools to be used, etc. |
| 1.3<br>Assess the work's feasibility | 1.3.1 Examine the work areas<br>1.3.2 Check the presence of constraints<br>1.3.3 Ensure that necessary materials and equipment are available<br>1.3.4 Estimate the work's duration<br>1.3.5 Send information to the foreman | The foreman makes a first assessment of the feasibility and duration of the work. Then millwrights are put to work; so this operation is often performed by a team. |

15. The sequence of operations may vary according to the company's organization.
16. "Superimposed work" means work done simultaneously in work areas located one on top of the other (superimposed). This type of work presents a major accident hazard, mainly because of objects (tools, materials, components, equipment, etc.) falling from the work area on top to the one below.

| TASK 1 INSTALL MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 1.4<br>Clear the work area | 1.4.1 Move or have others remove everything cluttering the work areas:<br>– rejects<br>– materials<br>– equipment<br>– tools<br>– etc. | It is necessary to remove or have others remove any object cluttering the work areas, threatening safety or hindering the work. |
| 1.5<br>Install scaffolds, if applicable | 1.5.1 Handle scaffolds up to its installation location<br>1.5.2 Proceed to the installation<br>1.5.3 Have the installation checked, if applicable | The millwright is always the one who installs the scaffolds he will use.<br>In some cases, for example if the client requires it, the installation must be approved by an engineer (1.5.3). |
| 1.6<br>Mobilize tools and equipment | 1.6.1 Select tools, equipment (including rigging and lifting equipment) and necessary products for the installation<br>1.6.2 Check the condition of tools and equipment<br>1.6.3 Store everything in a safe place until it is needed | |
| 1.7<br>Plan the layout of the machinery to be installed | 1.7.1 Take measurements<br>1.7.2 Set reference points<br>1.7.3 Trace the machinery's position<br>1.7.4 Check the layout | According to the participants, around 50% of millwrights are able to use the necessary instruments for the layout (e.g.: laser level).<br>However, the participants estimate that around 5% of millwrights use more-specialized instruments (e.g.: theodolite). Although the participants call those millwrights "instrument men," they are not surveyors, but millwrights who have acquired more thorough knowledge of how to use the instruments. They are the ones who provide the necessary data set for laying out the machinery. |
| 1.8<br>Fabricate the necessary parts for the installation, if applicable | 1.8.1 Draw the list of required parts and their characteristics (i.e.: measurements)<br>1.8.2 Proceed with the development<br>1.8.3 Trace the parts<br>1.8.4 Cut the parts<br>1.8.5 Assemble the parts, if applicable | The parts built (or modified) are, for example:<br>▪ the guardrail;<br>▪ the support point;<br>▪ templates;<br>▪ etc. |
| 1.9<br>Prepare the base to receive the machinery | 1.9.1 Bushhammer the concrete surface<br>1.9.2 Check the anchors<br>1.9.3 Check the elevations<br>1.9.4 Install shims and level the base<br>1.9.5 Clean the surface | |

| TASK 1 INSTALL MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 1.10<br>Put the machinery in place | 1.10.1 Analyse the lifting plan, if applicable<br>1.10.2 Check the capacity and scope of lifting equipment<br>1.10.3 Choose and install rigging accessories (slings, shackles, etc.)<br>1.10.4 Tie down the machinery to be moved<br>1.10.5 Lift and move the load, or guide the lifting equipment operator<br>1.10.6 Lay out the machinery on reference lines<br>1.10.7 Proceed with a prealignment, if applicable<br>1.10.8 Check the machinery's torque | |
| 1.11<br>Rectify the machinery's position | 1.11.1 Check the machinery's alignment and level<br>1.11.2 Align the machinery<br>1.11.3 Build shims<br>1.11.4 Install the shims and level the machinery | |
| 1.12<br>Apply grout between the concrete base and the machinery | 1.12.1 Clean the base<br>1.12.2 Moisten the concrete<br>1.12.3 Put the grout in place<br>1.12.4 Apply sealant on the hardened grout | Two types of grout are used: cement grout or epoxy grout. |
| 1.13<br>Lubricate the machinery, if applicable | 1.13.1 Check the type of lubricant to be used<br>1.13.2 Drain the storage oil, if applicable<br>1.13.3 Lubricate the machinery and couplings that must be lubricated<br>1.13.4 Clean reserve containers and oil level indicators<br>1.13.5 Fill tanks and reserve containers with oil | |
| 1.14<br>Perform idling tests and rotations | 1.14.1 Ensure that nothing hinders the motor's operation<br>1.14.2 Perform motor rotation tests<br>1.14.3 Couple the shafts<br>1.14.4 Install safety devices | This operation aims solely at checking the operation of the installed machinery's motor. |
| 1.15<br>Perform pre-operational checks | 1.15.1 Check the lubricant levels of all drive systems<br>1.15.2 Ensure that all components are free to operate<br>1.15.3 Check the belt tensions<br>1.15.4 Check the motor couplings | This operation is generally performed in a team, whose members are positioned at various locations and communicate by radio. That team is composed of millwrights, but not necessarily those who have done the installation. |

| **TASK 1 INSTALL MACHINERY** | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 1.16<br>Check the installation during startup | 1.16.1 Have the machinery prepared for startup<br>1.16.2 Ensure that the coupling is in place<br>1.16.3 Check the installation of safety devices<br>1.16.4 Have the machinery started up<br>1.16.5 Check the machinery's operation<br>1.16.6 Detect abnormal vibrations and noises<br>1.16.7 Detect any overheating and leaks | |
| 1.17<br>Make necessary corrections | 1.17.1 Adjust and regulate the machinery<br>1.17.2 Redo the tests, if necessary | |
| 1.18<br>Complete the work | 1.18.1 Clean the work area<br>1.18.2 Demobilize tools and equipment, lifting devices, scaffolds, etc.<br>1.18.3 Sort between recyclable and non-recyclable rejects<br>1.18.4 Dispose of rejects at appropriate locations | |
| **TASK 2 DO PREVENTIVE MAINTENANCE ON THE MACHINERY** | | |
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 2.1<br>Find out about the work to be done | 2.1.1 Read the plans<br>2.1.2 Read the work order<br>2.1.3 Receive the foreman's instructions<br>2.1.4 Take notice of anomalies already reported | |
| 2.2<br>Take safety measures | 2.2.1 Attend:<br>– the welcoming meeting on the construction site, if applicable<br>– your employer's welcoming meeting<br>– the meeting prior to superimposed work, if applicable<br>– various safety training<br>2.2.2 Learn about the permits, if applicable<br>2.2.3 Proceed with the lockout, if applicable<br>2.2.4 Establish a safety perimeter<br>2.2.5 Disconnect all power sources<br>2.2.6 Wear personal protective equipment<br>2.2.7 Participate in task safety analyses (TSA) | |
| 2.3<br>Install scaffolds, if applicable | 2.3.1 Handle scaffolds up to its installation location<br>2.3.2 Proceed with the installation<br>2.3.3 Have the installation checked, if applicable | See the clarifications of operation 1.5. |

| TASK 2 DO PREVENTIVE MAINTENANCE ON THE MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 2.4<br>Mobilize tools and equipment | 2.4.1 Select tools, equipment (including rigging and lifting equipment) and necessary products for the installation<br>2.4.2 Check the condition of tools and equipment<br>2.4.3 Store everything in a safe place until it is needed | |
| 2.5<br>Check the general condition of the production machinery | 2.5.1 Check the presence of leaks<br>2.5.2 Check whether parts or accessories have fallen to the ground (bolts, nuts, safety devices, etc.)<br>2.5.3 Check the machinery's cleanliness<br>2.5.4 Check the presence of paint discolouration or absence | |
| 2.6<br>Check the machinery's components | 2.6.1 Remove safety devices<br>2.6.2 Perform a general visual inspection<br>2.6.3 Examine each component (coupling, belts, pulleys, gears, chains, etc.)<br>2.6.4 Perform manual testing<br>2.6.5 Take temperature readings<br>2.6.6 Check the vibrations<br>2.6.7 Check tensions and deflections | |
| 2.7<br>Detect anomalies and signs of wear | 2.7.1 Check waste oils and other waste fluids during the draining (colour, presence of metals)<br>2.7.2 Detect any problem | When the millwright goes to a company to maintain machinery, production is stopped for the estimated duration of maintenance work. If the millwright detects that one or more components requires repairs, he can make repairs immediately if the estimated duration of maintenance is not lengthened; he can thus make minor repairs that take very little time. If he assesses that repairs will require more time, he will report this to his supervisors and the client company (in the maintenance report), and those repairs will be made at another time, to enable the planning of another production stop. |
| 2.8<br>Make minor corrections (adjust, regulate, etc.) | 2.8.1 Tighten belts and chains with tensioners<br>2.8.2 Tighten loose bolts and nuts<br>2.8.3 Adjust the oilers<br>2.8.4 Adjust the pressures<br>2.8.5 Change the filters | |
| 2.9<br>Lubricate the machinery and restore fluid levels | 2.9.1 Check the type of lubricant to be used<br>2.9.2 Lubricate the machinery and couplings that must be lubricated<br>2.9.3 Clean reserve containers and oil level indicators<br>2.9.4 Fill tanks and reserve containers with oil | |

| TASK 2 DO PREVENTIVE MAINTENANCE ON THE MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 2.10<br>Check the operation during startup | 2.10.1 Unlock<br>2.10.2 Have the machinery prepared for startup (electricity, pneumatic, etc.)<br>2.10.3 Have the machinery started up<br>2.10.4 Detect abnormal vibrations and noises<br>2.10.5 Detect any overheating and leaks<br>2.10.6 Make necessary adjustments | |
| 2.11<br>Complete the work | 2.11.1 Clean the work area<br>2.11.2 Demobilize tools and equipment, lifting devices, scaffolds, etc.<br>2.11.3 Sort between recyclable and non-recyclable rejects<br>2.11.4 Dispose of rejects at appropriate locations | |
| 2.12<br>Fill out a maintenance report | 2.12.1 Draw the list of:<br>– maintained equipment<br>– actions taken<br>– detected anomalies<br>– repairs to be made, if applicable | |
| **TASK 3 REPAIR MACHINERY** | | |
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 3.1<br>Find out about the work to be done | 3.1.1 Read the plans<br>3.1.2 Read the work order<br>3.1.3 Receive the foreman's instructions | In some cases, the order of operations 3.1 and 3.2 may be inverted. Indeed, occasionally an inspection of the machinery is necessary to learn about the work to be done, and this inspection cannot be made unless safety measures (for example, a lockout) have been taken. |
| 3.2<br>Take safety measures | 3.2.1 Attend:<br>– the welcoming meeting on the construction site, if applicable<br>– your employer's welcoming meeting<br>– the meeting prior to superimposed work, if applicable<br>– various safety training<br>3.2.2 Learn about the permits, if applicable<br>3.2.3 Proceed with the lockout, if applicable<br>3.2.4 Establish a safety perimeter<br>3.2.5 Disconnect all power sources<br>3.2.6 Wear personal protective equipment<br>3.2.7 Participate in task safety analyses (TSA) | |

| TASK 3 REPAIR MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 3.3<br>Install scaffolds, if applicable | 3.3.1 Handle scaffolds up to its installation location<br>3.3.2 Proceed with the installation<br>3.3.3 Have the installation checked, if applicable | See the clarification of operation 1.5. |
| 3.4<br>Mobilize tools and equipment | 3.4.1 Select tools, equipment (including rigging and lifting equipment) and necessary products for the installation<br>3.4.2 Check the condition of tools and equipment<br>3.4.3 Store everything in a safe place until it is needed | |
| 3.5<br>Remove any damaged components | | Depending on their dimensions and weight, damaged components can be removed manually or with lifting equipment (e.g.: crane). |
| 3.6<br>Clear the work area | 3.6.1 Move or have others move anything cluttering the work areas:<br>– rejects<br>– materials<br>– equipment<br>– tools<br>– etc. | This operation is performed at various moments during the work. |
| 3.7<br>Check the layout of the machinery to be repaired and redo it if necessary | 3.7.1 Measure the axles<br>3.7.2 Check the levels<br>3.7.3 Set reference points<br>3.7.4 Trace the machinery's position<br>3.7.5 Check the layout | |
| 3.8<br>Fabricate necessary parts for the repairs, if applicable | 3.8.1 Establish the list of required parts and their characteristics (i.e.: measurements)<br>3.8.2 Proceed with the development<br>3.8.3 Trace the parts<br>3.8.4 Cut the parts<br>3.8.5 Assemble the parts, if applicable | |
| 3.9<br>Repair or replace the machinery's damaged components | 3.9.1 Dismantle the components<br>3.9.2 Assess the relevance of repairing or replacing components<br>3.9.3 Measure the components<br>3.9.4 Repair components, if applicable (grind, drill, weld, etc.)<br>3.9.5 Check remaining components<br>3.9.6 Reinstall components (bolt, level, check the operation)<br>3.9.7 Adjuster components (new or repaired)<br>3.9.8 Lubricate and restore the oil level | Various reasons may justify repairing rather than replacing components, for example the cost of new components, the necessary waiting period to obtain them (order, delivery, etc.), etc. |

| TASK 3 REPAIR MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 3.10<br>Put repaired components back in place | | Depending on their dimensions and weight, repaired components can be put in place manually or with lifting equipment (e.g.: crane). |
| 3.11<br>Rectify the position of repaired components | 3.11.1 Fabricate thickness shims<br>3.11.2 Adjust the level<br>3.11.3 Adjust the alignment | |
| 3.12<br>Apply grout between the concrete base and the machinery | 3.12.1 Bushhammer the concrete surface<br>3.12.2 Build the formwork<br>3.12.3 Put the grout in place<br>3.12.4 Remove the formwork after drying<br>3.12.5 Clean the surface | |
| 3.13<br>Perform idling tests and rotations | 3.13.1 Establish a safety perimeter<br>3.13.2 Ensure that no object hinders the machinery's operation<br>3.13.3 Lockout the machinery<br>3.13.4 Decouple the machinery<br>3.13.5 Unlock the machinery<br>3.13.6 Perform motor rotation tests<br>3.13.7 Lockout the machinery<br>3.13.8 Recouple the shafts<br>3.13.9 Install safety devices | |
| 3.14<br>Check the repairs during startup | 3.14.1 Have the machinery prepared for startup<br>3.14.2 Ensure that the coupling is in place<br>3.14.3 Check the installation of safety devices<br>3.14.4 Have the machinery started up<br>3.14.5 Check the machinery's operation<br>3.14.6 Detect abnormal vibrations and noises<br>3.14.7 Detect any overheating and leaks | |
| 3.15<br>Make necessary corrections | 3.15.1 Adjust and regulate the machinery<br>3.15.2 Redo the tests if necessary | |
| 3.16<br>Complete the work | 3.16.1 Clean the work area<br>3.16.2 Demobilize tools and equipment, lifting devices, scaffolds, etc.<br>3.16.3 Sort between recyclable and non-recyclable rejects<br>3.16.4 Dispose of rejects at appropriate locations | |

## TASK 4 MODIFY MACHINERY

To make modifications, millwrights will, for example, change the characteristics of certain components, or introduce new technologies on a production chain. Those modifications are made mainly in order to improve productivity, extend the useful life of certain components, enable the production of different products, etc.

| *Operations* | *Sub-Operations* | *Clarifications* |
|---|---|---|
| 4.1<br>Find out about the work to be done | 4.1.1 Read the plans<br>4.1.2 Read the work order<br>4.1.3 Receive the foreman's instructions | |
| 4.2<br>Take safety measures | 4.2.1 Attend to:<br>– the welcoming meeting on the construction site, if applicable<br>– your employer's welcoming meeting<br>– the meeting prior to superimposed work, if applicable<br>– various safety training<br>4.2.2 Learn about the permits, if applicable<br>4.2.3 Proceed with the lockout, if applicable<br>4.2.4 Establish a safety perimeter<br>4.2.5 Disconnect all power sources<br>4.2.6 Wear personal protective equipment<br>4.2.7 Participate in task safety analyses (TSA) | |
| 4.3<br>Install scaffolds, if applicable | 4.3.1 Handle scaffolds up to its installation location<br>4.3.2 Proceed with the installation<br>4.3.3 Have scaffolds inspected, if applicable | See the clarifications of operation 1.5. |
| 4.4<br>Mobilize tools and equipment | 4.4.1 Select tools, equipment (including rigging and lifting equipment) and necessary products for the installation<br>4.4.2 Check the condition of tools and equipment<br>4.4.3 Store everything in a safe place until it is needed | |
| 4.5<br>Install a reference system | | This system is composed of numerous data to reinstall the machinery exactly in the same way, once the modification is completed. |
| 4.6<br>Dismantle the machinery to be modified | | |
| 4.7<br>Redo the layout of the machinery to be modified | 4.7.1 Take measurements<br>4.7.2 Set reference points<br>4.7.3 Trace the machinery's position<br>4.7.4 Check the layout | |

| TASK 4 MODIFY MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 4.8<br>Modify components | 4.8.1 Cut components<br>4.8.2 Extend components<br>4.8.3 Weld components<br>4.8.4 Assemble components | It is estimated that around one-third of millwrights have the skill to do welding work. The process used most often by millwrights is SMAW, but MIG and TIG are also used.<br>However, all millwrights have to do oxy-acetylene cutting or plasma arc cutting.<br>For certain types of welding work, millwrights must obtain certification from the Canadian Welding Bureau[17]. |
| 4.9<br>Fabricate the necessary parts for the modification, if applicable | 4.9.1 Establish the list of required parts and their characteristics (e.g.: measurements)<br>4.9.2 Proceed with the development<br>4.9.3 Trace the parts<br>4.9.4 Cut the parts<br>4.9.5 Assemble the parts, if applicable | |
| 4.10<br>Prepare the base to receive the machinery | 4.10.1 Bushhammer the concrete surface<br>4.10.2 Check the anchors<br>4.10.3 Check the elevations<br>4.10.4 Install shims and level the base<br>4.10.5 Clean the surface | |
| 4.11<br>Put the machinery in place | 4.11.1 Analyse the lifting plan, if applicable<br>4.11.2 Check the capacity and reach of lifting equipment<br>4.11.3 Choose and install rigging accessories (slings, shackles, etc.)<br>4.11.4 Tie down the machinery to be moved<br>4.11.5 Lift and move the load, or guide the operator of lifting equipment<br>4.11.6 Lay out the machinery on the reference lines<br>4.11.7 Proceed with a prealignment, if applicable | |
| 4.12<br>Rectify the machinery's position | 4.12.1 Check the machinery's alignment and level<br>4.12.2 Align the machinery<br>4.12.3 Fabricate the shims<br>4.12.4 Install the shims and level the machinery | |

17. Known in French as the Bureau canadien de soudage (BCS).

| TASK 4 MODIFY MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 4.13<br>Apply grout between the concrete base and the machinery | 4.13.1 Clean the base<br>4.13.2 Moisten the concrete<br>4.13.3 Put the grout in place<br>4.13.4 Apply sealant on the hardened grout, if applicable | |
| 4.14<br>Check the machinery's torque | | |
| 4.15<br>Lubricate the machinery, if applicable | 4.15.1 Check the type of lubricant to be used<br>4.15.2 Drain the storage oil, if applicable<br>4.15.3 Lubricate the machinery and the couplings that must be lubricated<br>4.15.4 Clean reserve containers and oil level indicators<br>4.15.5 Fill tanks and reserve containers with oil | |
| 4.16<br>Check the modification made | 4.16.1 Check the measurements of the modification made | |
| 4.17<br>Perform idling tests and rotations | 4.17.1 Establish a safety perimeter<br>4.17.2 Ensure that no object hinders the machinery's operation<br>4.17.3 Lockout the machinery<br>4.17.4 Decouple the machinery<br>4.17.5 Unlock the machinery<br>4.17.6 Perform motor rotation tests<br>4.17.7 Lockou the machinery<br>4.17.8 Recouple the shafts<br>4.17.9 Install safety devices | |
| 4.18<br>Check the modification during startup | 4.18.1 Have the machinery prepared for startup<br>4.18.2 Ensure that the coupling is in place<br>4.18.3 Check the installation of safety devices<br>4.18.4 Have the machinery started up<br>4.18.5 Check the machinery's operation<br>4.18.6 Detect abnormal vibrations and noises<br>4.18.7 Detect any overheating and leaks | |
| 4.19<br>Make necessary corrections | 4.19.1 Adjust and regulate the machinery<br>4.19.2 Redo testing if necessary | |

| TASK 4 MODIFY MACHINERY | | |
|---|---|---|
| ***Operations*** | ***Sub-Operations*** | ***Clarifications*** |
| 4.20<br>Complete the work | 4.20.1 Clean the work area<br>4.20.2 Demobilize tools and equipment, lifting devices, scaffolds, etc.<br>4.20.3 Sort between recyclable and non-recyclable rejects<br>4.20.4 Dispose of rejects at appropriate locations | |

## 2.3 ACHIEVEMENT CONDITIONS

Data on achievement conditions were collected for the millwright trade as a whole. The data pertain to aspects such as work areas, work instructions, health and safety hazards, reference documents consulted, material resources used, etc.

**Table 2.3 Achievement Conditions**

| ACHIEVEMENT CONDITIONS |
|---|
| **Work areas**[18]<br>Millwrights generally work in an environment marked by machinery noise. When working outdoors they face bad weather, and when working indoors they often work in dusty and extremely hot environments (e.g.: paper machines, cement kilns) that often contain pollutants and toxic products (e.g.: petrochemical industry).<br>Millwrights have to work from heights, in enclosed spaces, in restricted spaces, in tunnels or mines, etc. |
| **Collaboration and supervision**<br>For almost all their work, millwrights work in teams of at least two. Only maintenance work may at times be done individually. Depending on the scope of the work, in some cases (for example, when lifting a large heavy load) the team is composed of three to five millwrights. Millwrights work independently, under their foreman's timely supervision. |

18. Non-exhaustive list.

| ACHIEVEMENT CONDITIONS |
| --- |
| **Instructions and references**<br><br>Millwrights receive verbal instructions from their foreman, as well as written instructions (installation plans, lifting plans, etc.). Millwrights refer to manufacturer manuals for the machinery they install, repair, etc., and, for example, to torque specifications. They may also consult material safety data sheets of the Workplace Hazardous Materials Information System (WHMIS) when handling certain products. And finally, they use various tables (for drilling and threading). |
| **Stress factors**<br><br>The main stress factors are:<br><br>▪ machinery noise;<br>▪ working in enclosed spaces or from heights;<br>▪ explosion or contamination hazards related to certain work areas;<br>▪ some difficult lifting;<br>▪ the complexity of some of the work;<br>▪ the remoteness of certain construction sites;<br>▪ job insecurity;<br>▪ etc. |
| **Tools and equipment**<br><br>Annex 1 of this report contains a list of material resources used by millwrights in the practice of their trade. |
| **Health and safety hazards**<br><br>According to the participants, the main health and safety hazards facing millwrights are:<br><br>▪ falling when working from heights;<br>▪ being crushed when lifting;<br>▪ backache and knee pain;<br>▪ eye and finger injuries;<br>▪ hearing problems due to noise;<br>▪ breathing problems due to dust, welding work, etc.;<br>▪ various burns.<br><br>Moreover, Annex 2 of this report contains a detailed list of the main hazards related to the tasks and operations of the millwright trade, as well as applicable preventive measures. |

## 2.4 PERFORMANCE CRITERIA

Performance criteria were gathered for each task. They are used for assessing whether the tasks were performed satisfactorily. The criteria pertain to aspects such as the quantity and quality of work done, the observance of a work procedure, the attitudes adopted, etc.

To draw the list of criteria for each task, the participants worked in teams of two or three. Thus, certain criteria may at times apply to other tasks than those for which they have been retained.

**Table 2.4 Performance Criteria**

| **TASK 1 INSTALL MACHINERY** |
|---|
| **Performance Criteria** |
| – Observance of health and safety rules<br>– Respect for the environment<br>– Observance of instructions and the work order<br>– Observance of the plans and standards of machinery manufacturers<br>– Precise assessment of the work to be done and its feasibility<br>– Correct determination of necessary tools, equipment and accessories for doing the work<br>– Making precise measurements and cross-checking them<br>– Correct use of tools and observance of their capacities<br>– Correct lubrication of components<br>– Methodical work<br>– Harmonious and effective teamwork<br>– Orderly and clean place from start to completion the work |

**TASK 2 DO PREVENTIVE MAINTENANCE ON THE MACHINERY**

**Performance Criteria**

- Observance of health and safety rules
- Respect for the environment
- Observance of instructions and the work order
- Observance of the plans and standards of machinery manufacturers
- Precise assessment of the work to be done and its feasibility
- Correctly associating detected symptoms with resulting problems
- Correctly distinguishing between minor and major repairs
- Appropriate estimate of the necessary time for doing the work
- Correct determination of necessary tools, equipment and accessories for doing the work
- Making precise measurements and cross-checking them
- Correct use of tools and observance of their capacities
- Correct lubrication of components
- Methodical work
- Harmonious and effective teamwork
- Orderly and clean place from start to completion the work
- Complete and precise maintenance report

**TASK 3 REPAIR MACHINERY**

**Performance Criteria**

- Observance of health and safety rules
- Respect for the environment
- Observance of instructions and the work order
- Observance of the plans and standards of machinery manufacturers
- Precise assessment of the work to be done and its feasibility
- Correct determination of necessary tools, equipment and accessories for doing the work
- Carefully checking detected symptoms with personnel
- Meticulous inspection of the machinery to be repaired
- Precisely locating anomalies
- Determining appropriate solutions
- Correctly and fully repairing problems identified
- Making precise measurements and cross-checking them
- Correct use of tools and observance of their capacities
- Correct lubrication of components
- Methodical work
- Harmonious and effective teamwork
- Orderly and clean place from start to completion the work

| TASK 4 MODIFY MACHINERY |
|---|
| **Performance Criteria** |
| – Observance of health and safety rules<br>– Respect for the environment<br>– Observance of instructions and the work order<br>– Observance of the plans and standards of machinery manufacturers<br>– Meticulous inspection of the machinery to be modified<br>– Precise assessment of the work to be done and its feasibility<br>– Correct determination of necessary tools, equipment and accessories for doing the work<br>– Making precise measurements and cross-checking them<br>– Correct modification of machinery<br>– Appropriate operation of machinery after modifications<br>– Correct use of tools and observance of their capacities<br>– Correct lubrication of components<br>– Methodical work<br>– Harmonious and effective teamwork<br>– Orderly and clean place from start to completion the work |

## 2.5 FUNCTIONS

Functions are a set of interrelated tasks. That set may be defined by the work's results or by a procedure.

For the millwright trade, two functions appear to stand out:

- a function related to **installation and modification**, and grouping the following tasks:
  - Install machinery;
  - Modify machinery;
- a function related to **maintenance and repairs**, and grouping the following tasks:
  - Do preventive maintenance on the machinery;
  - Repair machinery.

# 3. QUANTITATIVE DATA ON TASKS

The data presented in the tables below are average results of the information mentioned by the workshop participants.

## 3.1 OCCURRENCE

**Occurrence** data concern the percentage of millwrights[19] who perform each task. They account not only for the work time of the workshop participants, but also for the participants' estimate of the work time of all millwrights.

**Table 3.1 Task Occurrence**

| Task | Occurrence |
|---|---|
| 1 Install machinery | 60% |
| 2 Do preventive maintenance on the machinery | 5% |
| 3 Repair machinery | 45% |
| 4 Modify machinery | 45% |

## 3.2 WORK TIME

**Work time**, expressed below in percentages, represents, the average time allocated to each task by the participants consulted, since the beginning of their careers.

**Table 3.2 Work Time Allocated to Each Task**

| Task | Work Time |
|---|---|
| 1 Install machinery | 49.5% |
| 2 Do preventive maintenance on the machinery | 5.6% |
| 3 Repair machinery | 27.8% |
| 4 Modify machinery | 17.1% |
| | 100.0% |

19. This percentage includes apprentices.

An examination of Table 3.2 reveals that machinery installation largely occupies millwrights' work time, i.e., around half of it (49.5%). Then come machinery repairs with slightly over one-quarter of hours worked (27.8%), and equipment modifications with 7.1% of work time. Lastly, the task that least occupies millwrights is preventive maintenance of machinery, which constitutes 5.6% of their work time.

Moreover, an examination of individual results reveals that all the persons consulted perform the four tasks.

## 3.3 IMPORTANCE AND DIFFICULTY OF TASKS

The **importance** of a task is estimated according to the more or less harmful consequences of performing a task poorly or not at all. The importance is assessed according to the following scale:

1. Not important at all: Poor execution of the task has no consequences on the quality of the result, the costs, health and safety, etc.

2. Not very important: Poor execution of the task could lead to minimal costs, a result of lesser quality, minor injury or accident hazards, etc.

3. Important: Poor execution of the task could lead to an unsatisfactory result, substantial additional costs, injuries, accidents, etc.

4. Very important: Poor execution of the task could lead to an unacceptable result and have very major consequences in terms of costs, safety, etc.

A task's **difficulty** is assessed according to the following scale:

1. Very easy: The task involves little risk of error; it requires no notable physical or mental effort. Performing the task is less difficult than average.

2. Easy: The task involves a few risks of error; it requires minimal physical or mental effort.

3. Difficult: The task involves many risks of error; it requires a good physical or mental effort. Performing the task is more difficult than average.

4. Very difficult: The task involves a high risk of error; it requires substantial physical or mental effort. The task is among the most difficult in the trade.

**Table 3.3 Importance and Difficulty of Tasks**

| Task | Importance | Difficulty |
|---|---|---|
| 1 Install machinery | 3.9 | 3.0 |
| 2 Do preventive maintenance on the machinery | 3.0 | 2.0 |
| 3 Repair machinery | 3.7 | 2.9 |
| 4 Modify machinery | 3.7 | 2.9 |

# 4. KNOWLEDGE, SKILLS AND ATTITUDES

The occupational analysis enabled us to specify some of the knowledge, skills and attitudes necessary for performing the tasks. Those qualities are transferable, i.e., applicable to a variety of tasks and situations.

The following pages present the knowledge, skills and attitudes that, according to the participants, are considered essential for performing the tasks of the millwright trade.

## 4.1 KNOWLEDGE

### *Chemistry and physics*

Knowledge of the properties of the various products and materials (particularly welding metals) with which he has to work is an asset for the millwright, as is knowledge of the various fluids (e.g.: oils) he uses. He must also have knowledge of:

- pressures;
- pulley systems;
- gears;
- Archimedes' principle;
- the centre of gravity of loads to be lifted and moved;
- etc.

### *Electricity*

Although millwrights have to install electrical components (mainly motors), basic electrical knowledge is sufficient for practicing their trade, because they do not have to make fittings and connections. For example, general knowledge of the operation of electric motors is an asset for them. However, millwrights must have a good knowledge of all hazards related to the use of electric equipment and materials (extension cords, tools, etc.), in order to eliminate accident hazards.

***Instruments***

Millwrights must know how to use a laser level, as well as various tools and instruments for, among other things, evaluating the level of different surfaces, the alignment of components (e.g.: dial indicator), etc. In addition, those acting as “instrument men” must know the principles and techniques that guide the use of more-specialized instruments, such as theodolites, total stations, etc.

***Reading plans***

Given that the millwright must read plans, he must have a basic knowledge of plan reading, for example regarding symbols, scales and legends. The plans he has to read may represent components or equipment in two or three dimensions. Occasionally, the millwright has to draw small sketches by hand, for example to explain a problem to his foreman.

***Lifting***

The millwright must apply necessary rigging techniques for loads to be lifted and moved. He must choose lifting equipment according to the load and capacity of each device. To that end, he must be able to calculate the loads’ weight. He must also be able to operate certain lifting devices (e.g.: lift) or guide the operator of devices with greater capacity. So knowledge of lifting signals is essential.

***Mathematics***

Application of mathematical knowledge is necessary to millwrights. Indeed, they must be comfortable mainly with the four basic operations and the rule of three, which are used for calculating, for example, ratios, material quantities, volumes and weights, and for converting units from one measuring system to another. They must be able to make those calculations with fractions and decimals.

Some work, for example machinery layout tracing, mainly requires knowledge of trigonometry and geometry, such as calculating areas, which requires the application of the Pythagorean theorem.

***Occupational health and safety***

Millwrights must know the preventive regulations and standards regarding health and safety, for themselves and other workers. In addition to the rules pertaining to laws and regulations, in some cases they must know what special measures to apply on certain construction sites and companies[20]. In those cases, they must take training sessions specific to those construction sites or companies, and attend meetings to keep apprised of important measures to be adopted.

Moreover, given that millwrights use a variety of products (lubricants, solvents, etc.), knowledge of WHMIS is very important; it enables them to know the precautions for using, transporting and storing those products.

***Welding and oxy-acetylene cutting***

All millwrights must know and be able to apply oxy-acetylene cutting and plasma arc cutting techniques. In addition, those who do welding work must of course know the various processes to use, their characteristics and limits, as well as the techniques to apply. They must also be able to interpret welding symbols. Moreover, for certain types of work, certification from the Canadian Welding Bureau may be required of them.

***Teamwork***

Given that millwrights work almost exclusively in teams, it is essential for them to be able to establish and maintain good relations with their colleagues and supervisors, and with workers in other trades (e.g.: crane operators).

## 4.2 SKILLS

Skills are types of know-how. They are divided into three categories: cognitive, motor and perceptual.

20. Regarding health and safety, some companies have internal policies that exceed legal requirements.

### 4.2.1 Cognitive Skills

Cognitive skills pertain to intellectual strategies applied in working. The main cognitive skills that millwrights need are the following:

- problem-solving;
- analysis;
- logic;
- concentration.

### 4.2.2 Motor Skills

Motor skills involve gestures and movements. The main motor skills that millwrights need are the following:

- dexterity;
- fine motor skill (handling very small objects);
- coordination.

### 4.2.3 Perceptual Skills

Perceptual skills are sensory skills enabling a person to perceive by his senses what is happening in his environment. The main perceptual skills that millwrights need are the following:

- visual memory (ability to remember the assembly sequence of parts, elements, etc.);
- perception of abnormal odours (e.g.: overheating);
- perception of abnormal noises (e.g.: abnormal motor rotation);
- spatial perception (e.g.: representation of moving parts);
- tactile perception (e.g.: touch recognition of unseen elements).

## 4.3 ATTITUDES

Attitudes are ways of acting, reacting and relating with others or with one's environment. They involve personal skills. The main attitudes millwrights need are the following:

- accuracy;
- attention to detail and diligence;
- initiative and resourcefulness;
- professional ethics;
- teamwork ability;
- respect for persons, equipment and tools;
- perseverance;
- interest in new developments, and adaptability;
- patience;
- punctuality;
- sense of observation.

# 5. TRAINING SUGGESTIONS

### *Initial training*

The participants made suggestions about various aspects of the initial training. They mainly suggest the following:

- favour the hiring of instructors who have not only theoretical knowledge, but also actual experience in the trade (this is reportedly not the case in some training centres);
- favour the registration of students with skills and a real interest in practicing the trade;
- increase the proportion of training directly related to the practice of the trade in the construction industry, for example by spending more time on learning how to operate a lift truck or how to sling and lift loads.

### *Continuous training and professional development*

Regarding professional development, the participants suggest the following:

- plan reading (2D and 3D) adapted to the needs of millwrights;
- welding;
- using instruments (e.g.: total stations);
- parts development;
- managing a small work team;
- computer use applied to the work of millwrights.

The participants emphasize the importance of hiring instructors with experience in the construction industry. Lastly, they suggest reducing the number of persons required for a course to be offered, which would avoid cancelling courses too frequently.

# Annexes

## Annex 1

**TOOLS AND EQUIPMENT**

Lists of raw materials, tools and equipment originating from the national occupational analysis (Red Seal) of the millwright trade were presented to the participants during the workshop. The following pages contain, for each task, the list of raw materials, tools and equipment validated by the participants.

### Table A.1 Tools and Equipment

Shaded boxes indicate items that are **not** used.

| | Install machinery | Do preventive maintenance on the machinery | Repair machinery | Modify machinery |
|---|---|---|---|---|
| **HAND TOOLS** | | | | |
| threading accessories | | | | |
| reamers | | | | |
| alignment bar | | | | |
| pinch bar | | | | |
| parallel bars | | | | |
| brushes (wire, cleaning, etc.) | | | | |
| oil can | | | | |
| calculator | | | | |
| tin snip | | | | |
| chisel | | | | |
| socket wrench | | | | |
| pipe wrench | | | | |
| torque wrench | | | | |
| wrenches | | | | |
| Allen keys | | | | |
| adjustable wrenches | | | | |
| trammels | | | | |

| | Install machinery | Do preventive maintenance on the machinery | Repair machinery | Modify machinery |
|---|---|---|---|---|
| pipe and tube cutters | | | | |
| wheel dresser | | | | |
| puller | | | | |
| tap extractor | | | | |
| drill bit | | | | |
| scraper | | | | |
| nibbler | | | | |
| files | | | | |
| hammer | | | | |
| hammer, deadblow | | | | |
| hammer, claw | | | | |
| hammer, ball peen | | | | |
| hammer, chipping | | | | |
| hammer, rubber | | | | |
| Hammer, soft faced | | | | |
| levels (carpenter, machinist, torpedo, etc.) | | | | |
| thread chaser | | | | |
| honing stone | | | | |
| locking pliers | | | | |
| pliers | | | | |
| grease gun | | | | |
| punch | | | | |
| pop riveter | | | | |
| hacksaw | | | | |
| clamps | | | | |
| taps and dies | | | | |
| screwdrivers | | | | |
| scriber | | | | |
| trowel | | | | |
| lock | | | | |

| | Install machinery | Do preventive maintenance on the machinery | Repair machinery | Modify machinery |
|---|---|---|---|---|
| **MEASURING AND LAYOUT TOOLS** | | | | |
| V-block | | | | |
| gauge block | | | | |
| bore gauge | | | | |
| height gauge | | | | |
| small hole gauge | | | | |
| radius gauge | | | | |
| solid square | | | | |
| dial indicator | | | | |
| outside calipers | | | | |
| inside calipers | | | | |
| dividers | | | | |
| piano wire | | | | |
| chalk line | | | | |
| chalk line | | | | |
| deflection gauge | | | | |
| engineers' square | | | | |
| laser alignment equipment | | | | |
| plumb bob | | | | |
| sheave gauge | | | | |
| gear pitch gauge | | | | |
| taper gauge | | | | |
| thread gauge | | | | |
| plastic gauge | | | | |
| depth gauge | | | | |
| indicator gauge | | | | |
| telescopic gauge | | | | |
| combination square set | | | | |
| micrometer | | | | |
| optical level | | | | |
| vernier caliper | | | | |

| | Install machinery | Do preventive maintenance on the machinery | Repair machinery | Modify machinery |
|---|---|---|---|---|
| protractor | | | | |
| tape measures | | | | |
| tension gauge | | | | |
| transits | | | | |
| height gauge | | | | |
| taper gauge | | | | |
| **PORTABLE POWER TOOLS** | | | | |
| hydraulic ram | | | | |
| heat gun | | | | |
| impact wrench | | | | |
| hydraulic wrenches | | | | |
| hydraulic nuts | | | | |
| power threader | | | | |
| tube roller | | | | |
| hammer drill | | | | |
| jack hammer | | | | |
| die grinder | | | | |
| impact drill | | | | |
| angle drill | | | | |
| portable drill | | | | |
| impact gun (rivet) | | | | |
| portable bender | | | | |
| chainsaw | | | | |
| power band saw | | | | |
| reciprocating saw | | | | |
| circular saw | | | | |
| jig saw | | | | |
| chop saw | | | | |

| | Install machinery | Do preventive maintenance on the machinery | Repair machinery | Modify machinery |
|---|---|---|---|---|
| **WELDING AND CUTTING EQUIPMENT** | | | | |
| metal inert gas welding (MIG) equipment | | | | |
| tungsten inert gas welding (TIG) equipment | | | | |
| arc welding equipment | | | | |
| plasma arc cutting equipment | | | | |
| oxy-acetylene welding equipment | | | | |
| rod ovens | | | | |
| welding machines | | | | |
| **TESTING EQUIPMENT** | | | | |
| scales | | | | |
| radio transmitter | | | | |
| borescope | | | | |
| laser alignment equipment | | | | |
| vibration analysis workshop | | | | |
| balancing equipment | | | | |
| hardness test equipment | | | | |
| viscosity test equipment | | | | |
| thermographic test equipment | | | | |
| printer | | | | |
| pressure/vacuum gauge | | | | |
| hydraulic gauge | | | | |
| multimeter | | | | |
| computer | | | | |
| tachometer | | | | |
| theodolite | | | | |
| **ACCESS, RIGGING, HOISTING AND LIFTING EQUIPMENT** | | | | |
| sheaves block | | | | |
| chains | | | | |
| dolly | | | | |
| caterpillar tracks (skates) | | | | |

| | Install machinery | Do preventive maintenance on the machinery | Repair machinery | Modify machinery |
|---|---|---|---|---|
| trolley | | | | |
| scaffold | | | | |
| ladder | | | | |
| fork lift | | | | |
| sling | | | | |
| gantry | | | | |
| mobile crane | | | | |
| shackle | | | | |
| aerial lift | | | | |
| cable hoist | | | | |
| chainfall | | | | |
| block and tackle | | | | |
| hydraulic block | | | | |
| power chain block | | | | |
| spreader bars | | | | |
| overhead crane | | | | |
| gantry crane | | | | |
| snatch block | | | | |
| scissor lift | | | | |
| grip hoist | | | | |
| come-along | | | | |
| air tuggers | | | | |
| jack | | | | |
| screw jack | | | | |
| hydraulic jack | | | | |
| air jack | | | | |

| | Install machinery | Do preventive maintenance on the machinery | Repair machinery | Modify machinery |
|---|---|---|---|---|
| **PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT** | | | | |
| safety footwear | | | | |
| hard hat | | | | |
| coveralls (all types: acid, chemical, fire resistant, etc.) | | | | |
| eye wash station | | | | |
| welding blinds | | | | |
| gloves | | | | |
| life jacket | | | | |
| safety vest | | | | |
| safety harness and fall arresting device | | | | |
| goggles | | | | |
| breathing protection (paper filter masks to self-contained breathing apparatus) | | | | |
| hearing protection | | | | |
| apron | | | | |
| first aid kit | | | | |
| face shield | | | | |

## Annex 2

### MATRIX OF OCCUPATIONAL HEALTH AND SAFETY HAZARDS

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**Table A.2 Occupational Health and Safety Hazards for the Millwright Trade**

| No. | Hazards | Effects on Health and Safety | Means of Prevention |
|---|---|---|---|
| 1 | **Ergonomic Hazards and Dangers**<br>– Kneeling work posture maintained for a long time<br>– Handling long parts or heavy loads, often weighing around 50 kg | – Knee pain or backache<br>– Fatigue<br>– Discomfort<br>– Sprain<br>– Hernia | • Wear knee pads.<br>• Take training in handling techniques adapted to loads to be lifted.<br>• Use handling equipment.<br>• Work in twos to handle loads. |
| 2 | **Fall-from-height Hazards and Dangers**<br>**a) Areal automotive work platform**<br>**b) Metal frame scaffold**<br>**c) Stepladder**<br>**d) Ladder**<br>**e) Guardrail** | – Collisions<br>– Internal injuries<br>– Fractures<br>– Bruises<br>– Psychological and physical after-effects<br>– Death | a) – Wear an energy-absorbing harness for the jib boom platform.<br>– Delimit the work area to avoid collision hazards.<br>– Keep the feet on the platform floor.<br>– Climb up and down facing the equipment, while maintaining three support points.<br>– Keep the platform accesses and floor clean.<br>b) When there is a risk of falling more than 3 metres[21]:<br>– install a railing or wear a shock-absorbing harness, either with an anchor that has a breaking strength of 18 kN or with a vertical lifeline, according to the specifications in the Safety Code;<br>– check the soil bearing capacity and install beds and jack screws if the ground is sloping;<br>– for each scaffolding section, install vertical locks;<br>– use safe means of access;<br>– install anchors to the structure at intervals not exceeding three times the minimum scaffold width;<br>– ensure that the planks are NLGA certified;<br>– ensure that the floor is wide enough (min. 470 mm);<br>– ensure that the distance between the structure and the floor is less than 350 mm.<br>c) Class 1 stepladder, building and industry:<br>– keep the spreader bars fully open;<br>– install on a firm level surface;<br>– choose according to the height to be attained. |

21. Some client companies may have standards that exceed this requirement and oblige workers to take those measurements even if the risk is of falling less than three metres.

| No. | Hazards | Effects on Health and Safety | Means of Prevention |
|---|---|---|---|
| | | | d) Class 1 ladder, building and industry:<br>– install on a solid base, with top support on both side rails;<br>– maintain the support plan of ⅓ to ¼;<br>– secure and exceed by at least 900 mm (3 ft.) the plan to be attained.<br>e) Ensure that the guardrail has a concentrated horizontal force resistance of 900 N and a concentrated vertical force resistance of 450 N. |
| **3** | **Chemical Hazards and Dangers**<br>– Epoxy-based / cement grout<br>– Silica dust (sand)<br>– Lubricator<br>– Carbon monoxide fumes (equipment with incomplete combustion), for example during use of a chain saw, telescopic fork lift, etc.<br>– Unhealthy environment (working in enclosed spaces)<br>– Air quality: percentage of oxygen and of chemical, poisonous and asphyxiating gases | – Skin disorders (dermatoses)<br>– Organism intoxication<br>– Respiratory illnesses<br>– Sensitivity to products<br>– Eye lesions<br>– Death | • Took WHMIS training.<br>• Have material safety data sheets on site.<br>• Wear respiratory protection with appropriate filters for contaminants.<br>• Ensure mechanical or natural ventilation.<br>• Wear appropriate personal protective equipment (gloves, coveralls).<br>• Favour the use of electric equipment to prevent CO poisoning.<br>• Use a gas detector in good condition (drift test and calibration).<br>• Ensure that the percentage of oxygen is between 19.5 and 23%.<br>• In the presence of flammable vapour or gas, adjust the gas detector at a safety factor of 25% of the lower limit of the product's explosiveness.<br>• Observe the exposure values provided by the Occupational Health and Safety Regulations. |
| **4** | **Hot work Hazards and Dangers** | – Fire<br>– Explosion<br>– Skin burns<br>– Malaise<br>– Eye irritation<br>– Poisoning<br>– Electric discharge | • Have a fire extinguisher at hand.<br>• Wear appropriate personal protective equipment (gloves, goggles, apron, leggings, etc.)<br>• Use fire-resistant screens and covers. |
| **5** | **Hazards and Dangers related to a non-neutralized energy source**<br>– Electrical source<br>– Mechanical source<br>– Pneumatic source<br>– Hydraulic source (conveyor and others) | – Burns<br>– Amputation<br>– Being crushed<br>– Electrification<br>– Electrocution | • Use an extension cord in good condition.<br>• Lock out all energy sources.<br>• Ensure double insulation on power tools. |
| **6** | **Noise Hazards and Dangers (from the work environment)** | – Hearing loss<br>– Occupational deafness<br>– Fatigue<br>– Stress | • Isolate the noise source.<br>• Wear appropriate hearing protection (plugs, earmuffs). |

| No. | Hazards | Effects on Health and Safety | Means of Prevention |
|---|---|---|---|
| **7** | **Weather Hazards and Dangers**<br>– Humidity<br>– Cold<br>– Heat<br>– Wind | – Hypothermia<br>– Arthritis<br>– Heat stroke<br>– Chilblain<br>– Virus<br>– Bacteria | • Drink water regularly.<br>• Reduce the pace of work.<br>• Take breaks more often.<br>• Wear synthetic clothing in layers when the weather is cold. |
| **8** | **Physical stressors**<br>**a) Vibrations (using a bolter (zip gun), jack hammer, chainsaw)**<br>**b) Collision, falling or being crushed (by a sling, when a lift truck is being used, etc.)** | a) – Vascular disorders (Raynaud's syndrome)<br>– Neurological disorders (carpal tunnel syndrome), tendons, ligaments, etc.<br>b) – Death<br>– Amputation<br>– Fracture | a) – Favour the purchase of tools complying with the European directive on vibrations.<br>– Have a tool in good condition.<br>– Favour the alternation of tasks.<br>b) – Know the attachment methods.<br>– Use accessories in good condition and adapted to the load to be lifted.<br>– Have a lifting plan. |