Pipe Welder
(high pressure)

Occupational Analysis Report

November 2013

Commission
de la construction
du Québec

The purpose of this report is to describe as accurately as possible the occupation of pipe welder (high pressure) as currently practiced in Quebec'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.

The occupational analysis is a first step in the definition of the competencies required for practicing the occupation. 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

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April 4, 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 of the construction industry's trades and occupations.

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 and specialized occupation;

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

- 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 provincial profile of the various trades and specialized occupations.

The occupational analysis of the pipe welder (high pressure) specialized occupation belongs to this context[3]. Its purpose is to describe this specialized occupation as currently practiced 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 March 23 and 24, 2013.

This analysis draws a portrait of the occupation (tasks and operations) and its working conditions, and identifies the skills and behaviours required. The report of the occupational analysis workshop is an accurate reflection of the consensus reached by a group of experienced pipe welders. 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 occupation 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 OCCUPATION

1.1 DEFINITION OF THE SPECIALIZED OCCUPATION

According to the collective agreements' subschedules, "pipe welder" means:

ANYONE WHO:

a) Performs pipe welding work pursuant to the Act respecting pressure vessels (R.S.Q., c. A-20.01) and its regulations;

b) Performs, in accordance with the above provisions, all other pipe welding work on such facilities and installations as oil refineries, gasoline pumps and vent and sprinkler systems.

According to the participants in the occupational analysis, the work of pipe welders on construction sites should be recognized as a trade to the same extent as the other trades mentioned in the Regulation respecting the vocational training of workforce in the construction industry.

Moreover, the participants consider the definition incomplete in describing relevant types of piping and sectors of activities. The participants state that the definition should mention the following:

- piping used in industrial processes such as petrochemistry, pulp and paper, mineral processing, food processing, etc.;
- piping related to building mechanics, such as found in steam systems, cooling systems, etc.;
- piping used for energy production, distribution or supply, such as natural gas and hydroelectricity.

It should also be mentioned that pipe welders take part in manufacturing and assembling metal parts such as anchors and supports.

1.2 JOB TITLES

The job titles used for describing the specialized occupation are “pipe welder,” “pipe welder (high pressure),” “pipeline welder,” “supply welder” or “high pressure welder” (the latter is the occupation’s former title).

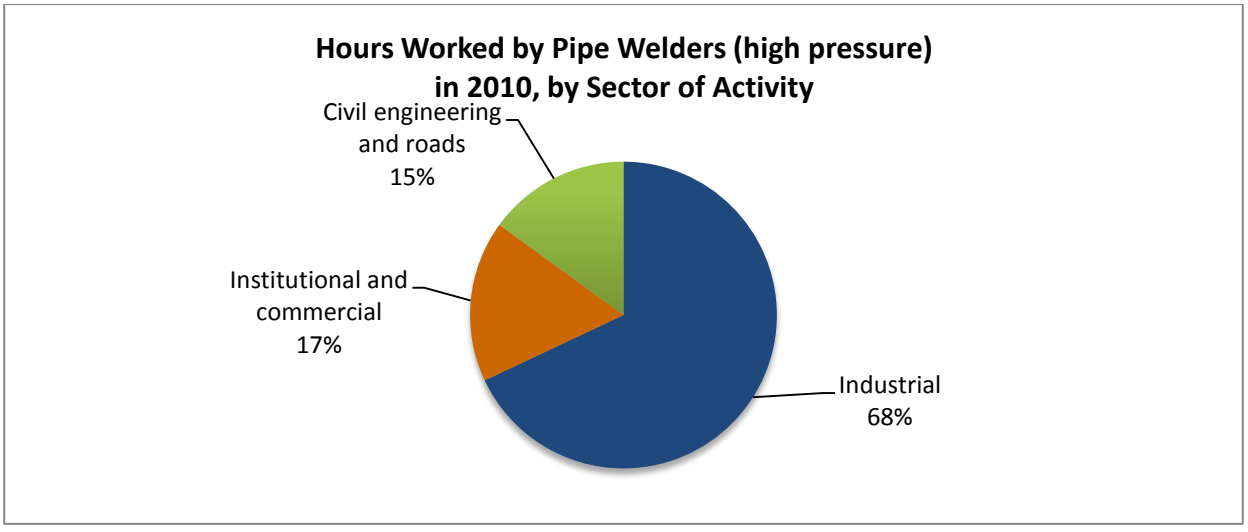
Given that other trades and occupations include welding work, the work of pipe welders (high pressure) should not be confused with that of pipe fitters, refrigeration mechanics, boiler makers or welders.

1.3 SECTORS OF ACTIVITY

Pipe welders are active in three of the four construction industry sectors:

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

The graphic below illustrates the distribution of hours worked by pipe welders in 2010[4]:



The pipe welders attending the workshop specify that hospital and real estate infrastructure projects may imply that the above graphic under-represents the institutional and commercial sector compared to the industrial sector.

4. Commission de la construction du Québec, *Careers in Construction*, 2011-2012 edition.

In their view, we may observe an upward trend of hours worked in the institutional and commercial sector in coming years, but a downward trend in the industrial sector due to the closure of refineries and the increase in workshop manufacturing.

Asked about the sector of activity in which they work, five participants answered that they work mainly in the civil engineering and roads sector; four participants, in the industrial sector; and three others, in the institutional and commercial sector.

All the participants work in at least one other sector. Thus, seven participants reported working also in the industrial sector; four, in the civil engineering and roads sector; and one, in the institutional and commercial sector.

1.4 FIELD OF PRACTICE

The occupation'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 construction 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 construction 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, REGULATIONS AND STANDARDS

Pipe welders 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 Act respecting pressure vessels (R.S.Q., c. A-20.01);
- the National Building Code – Canada (NBC);
- the National Plumbing Code – Canada (NPC);
- the Québec Building Code, Chapter I, “Building”;
- the Québec Building Code, Chapter III, “Plumbing”;
- the Act respecting occupational health and safety (R.S.Q., c. S-2.1, r.6);
- the Safety Code for the construction industry (R.Q., c. S-2.1, r.6);
- municipal bylaws, where applicable.

In addition, the work of pipe welders must meet the requirements of several standards, such as standards CSA B51, ASME B31.3 and CSA Z662, for example.

1.6 WORKING CONDITIONS

The following information[5] provides an overview of the conditions and context of the work of pipe welders, 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 construction industry’s four sector-based collective agreements.

Salary

The average annual salary of a pipe welder (high pressure) who worked at least 500 hours in 2010 was $55,820. 63% of pipe welders had worked at least 500 hours in that period.

The hourly wage varies slightly depending on the sector of activity. On April 29, 2012, the daytime hourly wage was as follows:

- Industrial: $34.79
- Institutional and commercial: $34.79
- Civil engineering and roads: $34.91

5. The data presented in this section are taken from the construction industry’s four sector-based collective agreements and from the following document, published by the Commission de la construction du Québec: *Careers in Construction*, 2011-2012 edition.

The participants specify that the hourly wage may be increased in certain circumstances. For example, heavy industry work is paid $37.30 per hour, and pipeline work $39.40 per hour.

Vacations and time off

Mandatory annual holidays of four weeks – two weeks in summer and two in winter at periods predetermined 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 participate in 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.

Physical requirements

The work of pipe welders requires:

- endurance to cold and heat;
- flexibility and agility, to reach locations difficult to access;
- dexterity;
- good gesture coordination;
- good visual acuity.

According to the participants, not being subject to vertigo and claustrophobia constitutes an advantage for pipe welders working from heights and in confined spaces.

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 may be a maximum of 10 hours, within a 40-hour work week.

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, make-up time in the light residential sector, etc. These special schedules confer flexibility to the work schedules in effect in the construction industry.

According to the participants in the occupational analysis, the work usually takes place in the daytime. However, certain sites in the heavy industry sector (refineries, for example) or in the civil engineering and roads sector (pipelines, for example) require more hours of work per week.

Stress factors

The specialized occupation of pipe welder involves stress factors. The following are stress factors mentioned by the persons attending the analysis workshop:

- the obligation to qualify in order to obtain work;
- possibilities of execution errors;
- non-destructive test results;
- pipe welding under load;
- occupational health and safety hazards (for example, work on pressure vessels);
- the "closed" work environment due to wearing a mask, thus entailing a loss of contact with the work environment;
- working under pressure and with tight deadlines.

1.7 WORK ORGANIZATION

Pipe welders work in teams with other welders and pipe fitters. They are supervised by foremen.

1.8 JOB MARKET ENTRY CONDITIONS

To practice the specialized occupation of pipe welder (high pressure) in the construction industry, a candidate must:

- be at least 16 years of age;
- have successfully passed the course *Santé et sécurité générale sur les chantiers de construction*;
- have successfully passed or passing the *Cours de connaissance générale de l'industrie de la construction* (CCGIC)[6].

Of the analysis workshop participants, ten took welding training in school and two learned at work. Three took the study program leading to the Attestation of Vocational Specialization (ASP) in High-Pressure Welding.

The participants in the occupational analysis workshop pointed out that on-the-job training is common in the practice of the occupation. They add that pipe welders must, to be hired, regularly pass qualification tests on welding processes and procedures.

Moreover, certain qualities are sought by employers hiring new pipe welders. The following list presents the main qualities:

- qualification;
- mastery of several processes and the capacity to work on various alloys;
- attention to detail;
- experience;
- work quality;
- quick execution or productivity;
- teamwork ability.

6. Other conditions than those listed may apply. For a complete list of entry conditions for this occupation, 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.

1.9 PLACE OF WOMEN IN THE OCCUPATION

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, 5 women were practicing the occupation of pipe welder (high pressure) in 2010, out of a total of 546 persons, i.e., a percentage of 0.9%.

According to the pipe welders attending the workshop, the low presence of women may be explained by the occupation's physical requirements and by employers' persistent prejudice.

1.10 CAREER PROSPECTS

According to the participants, the career prospects of pipe welders are limited. This is reportedly because the work is not recognized as a trade under the Regulation respecting the vocational training of workforce in the construction industry, so that access to foreman positions is difficult.

Moreover, pipe welders have the possibility of becoming inspectors. However, the analysis workshop participants specified that this type of employment is not very attractive because the pay is lower.

1.11 DEVELOPMENT OF THE SPECIALIZED OCCUPATION

Plant-manufactured products, new connecting flanges, fibreglass pipes, the development of fusion welding and the automation of certain welding processes (for example, orbital welding) have had major consequences on the practice of the occupation, by reducing the volume of work.

This situation has reduced the number of pipe welders and caused a number of them to leave Quebec for other Canadian provinces (particularly Alberta, in the petroleum development and processing sector).

1.12 IMPACT OF ENVIRONMENTAL STANDARDS ON THE PRACTICE OF THE SPECIALIZED OCCUPATION

The main effects of environmental standards on the practice of the occupation pertain to tighter requirements for the disposal of rejects and to improved air and gas exhaust mechanisms on construction sites.

2. WORK DESCRIPTION

2.1 TASKS AND OPERATIONS

List of tasks

The following list presents the main tasks performed by pipe welders. The order in which the tasks are presented does not necessarily reflect their importance in the specialized occupation.

Task 1 Weld piping

Task 2 Repair welding work

Task 3 Participate in prepairing and assembling parts

The welding procedures used are:

- SMAW: shielded metal arc welding;
- GTAW: gas tungsten arc welding;
- GMAW: gas metal arc welding;
- FCAW: flux cored arc welding;
- SAW: submerged arc welding.

The table of pipe welder tasks and operations is presented in the following pages.

Table 2.1 Tasks and Operations

TASKS	OPERATIONS					
1. WELD PIPING	1.1 Learn about the work to be done	1.2 Take health and safety preventive measures	1.3 Inspect the assembly	1.4 Prepare the welding work	1.5 Take measures to prevent warping	1.6 Purge the pipe according to the specifications and welding procedure, if applicable
	1.7 Perform preheating operations, if applicable	1.8 Make the first pass (root pass)	1.9 Clean the joint between passes	1.10 Make a visual inspection of the welding work	1.11 Make filling passes	1.12 Make the reinforcing pass(es)
	1.13 Check your work	1.14 Identify the welding work	1.15 Inform the person responsible that the work is completed			
2. REPAIR WELDING WORK	2.1 Learn about the nature of repairs to be made	2.2 Choose the repair strategy	2.3 Make repairs			
3. PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS	3.1 Learn about work guidelines and instructions	3.2 Handle the parts	3.3 Measure the parts	3.4 Shape the parts	3.5 Clean the parts	3.6 Join the parts
	3.7 Tack the parts	3.8 Check the work quality				

2.2 OPERATIONS, SUB-OPERATIONS AND CLARIFICATIONS

In the following pages are presented the sub-operations related to some of the operations, as well as a few clarifications made by the participants.

Table 2.2 Sub-Operations and Operation Clarifications

TASK 1 WELD PIPING

The welding processes used are SMAW, GTAW, GMAW, FCAW and SAW.
The SAW process is used mainly in the workshop.

Operations	Sub-Operations	Clarifications
1.1 Learn about the work to be done	1.1.1 Interpret the waybill 1.1.2 Interpret the welding procedure	The welding procedure includes specifications for types of welding processes as well as types of joints, base and filler metals, angles, chamfers, diameters, welding positions, gases, heat treatments, etc.
1.2 Take health and safety preventive measures	1.2.1 Put on the personal protective equipment 1.2.2 Make sure to prepare the work area according to health and safety rules	
1.3 Inspect the assembly	1.3.1 Check the joint's cleanliness 1.3.2 Check the chamfer angle 1.3.3 Check the root face (root thickness) 1.3.4 Check the alignment of parts 1.3.5 Check the root gap	
1.4 Prepare the welding work	1.4.1 Install the welding equipment 1.4.2 Prepare the welding material 1.4.3 Check the good operation of equipment: • electric cable breaks • polarity • grounding 1.4.4 Adjust welding parameters according to the welding process and procedure	

TASK 1 WELD PIPING

Operations	Sub-Operations	Clarifications
1.5 Take measures to prevent warping	1.5.1 Determine the welding sequence or learn about it to control warping 1.5.2 Install restraint devices	
1.6 Purge the pipe according to the specifications and welding procedure, if applicable		
1.7 Perform preheating operations, if applicable		
1.8 Make the first pass (root pass)	1.8.1 Choose the filler metal according to the welding process 1.8.2 Position yourself 1.8.3 Make the welding pass: • in 1G, 2G, 5G and 6G positions • up hand and down hand welding 1.8.4 Adjust the intensity	
1.9 Clean the joint between passes	1.9.1 Clean the joint between passes by brushing 1.9.2 Clean the joint between passes by grinding	
1.10 Make a visual inspection of the welding work		A visual inspection should be made between each welding pass.
1.11 Make filling passes	1.11.1 Position yourself 1.11.2 Make the welding pass: • in 1G, 2G, 5G and 6G positions • up hand and down hand welding 1.11.3 Adjust the intensity	Filling passes are made by successive layers with filler metals recommended in the welding procedure. The diameter of filler metals may change with the passes.

TASK 1 WELD PIPING

Operations	Sub-Operations	Clarifications
1.12 Make the reinforcing pass(es)	1.12.1 Position yourself 1.12.2 Make the welding pass: • in 1G, 2G, 5G and 6G positions • upward and downward welding 1.12.3 Adjust the intensity	Reinforcing passes are made by applying appropriate techniques and using filler metals recommended in the welding procedure.
1.13 Check your work		
1.14 Identify the welding work	1.14.1 Identify the welding work with a punch or marker OR 1.14.2 Identify the welding work by filling out the ISO form	
1.15 Inform the person responsible that the work is completed		The person responsible is usually the foreman or inspector.

TASK 2 REPAIR WELDING WORK

The SMAW, GTAW GMAW or FCAW welding process may be used in repairs. The welding process used for repairs may be different from the one used originally.

Operations	Sub-Operations	Clarifications
2.1 Learn about the nature of repairs to be made	2.1.1 Learn about the results of non-destructive tests 2.1.2 Locate welding defect(s): • use measuring instruments • mark the location 2.1.3 Discuss with the person responsible (foreman or inspector), if applicable	Welding defects may be, for example: • lack of fusion; • porosities; • presence of undercuts; • slag inclusions; • excessive build-up; • lack of thickness; • cracks; • etc.
2.2 Choose the repair strategy	2.2.1 Determine with the person responsible (foreman or inspector) the repair sequence to be adopted for the repairs 2.2.2 Choose the necessary repair techniques and methods (gouging, grinding, disassembling, etc.)	Gouging consists of obtaining kerfs similar to those produced by a chisel.

TASK 2 REPAIR WELDING WORK

Operations	Sub-Operations	Clarifications
2.3 Make repairs	2.3.1 Preheat, if applicable 2.3.2 Do repair welding (see task 1) 2.3.3 Apply heat treatments, if applicable	Repairs may be made by using a different welding process than the one used originally.

TASK 3 PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS

The welding processes used for tacking are SMAW, GTAW, GMAW and FCAW.

Operations	Sub-Operations	Clarifications
3.1 Learn about work guidelines and instructions	3.1.1 Interpret the waybill 3.1.2 Interpret the manufacturing plan or drawing 3.1.3 Interpret the welding procedure	The welding procedure includes specifications for types of welding processes as well as types of joints, base and filler metals, angles, chamfers, diameters, welding positions, gases, heat treatments, etc.
3.2 Handle the parts		
3.3 Measure the parts	3.3.1 Size the necessary parts (plates or piping components) for welding	
3.4 Shape the parts	3.4.1 Cut the parts 3.4.2 Fold the parts 3.4.3 Bend the parts 3.4.4 Drill the parts 3.4.5 Chip the parts 3.4.6 Thread the parts 3.4.7 Chamfer the parts mechanically or by oxygen cutting	The purpose of shaping parts is often to make supports and anchors.
3.5 Clean the parts	3.5.1 Degrease the parts 3.5.2 Grind the parts 3.5.3 Trim the parts 3.5.4 Sand the parts 3.5.5 Brush the parts 3.5.6 File the parts	
3.6 Join the parts	3.6.1 Level a part 3.6.2 Immobilize the part 3.6.3 Put a second part in place 3.6.4 Align and square the parts	The junction of parts may be done in multiple ways: by overlapping, end-to-end, by socketing, etc.

TASK 3 PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS		
Operations	**Sub-Operations**	**Clarifications**
3.7 Tack the parts		Tacking techniques are applied according to established standards: size, dimensions, location, heating temperature, tack length.
3.8 Check the work quality	3.8.1 Check that measurements are exact 3.8.2 Check the tacking	

2.3 ACHIEVEMENT CONDITIONS AND PERFORMANCE CRITERIA

2.3.1 ACHIEVEMENT CONDITIONS

Data on achievement conditions were collected for the pipe welder (high pressure) specialized occupation as a whole. The data pertain to aspects such as work areas, sectors, level of collaboration, instructions and references, metals used, and health and safety hazards.

Annex 1 contains a list of tools and equipment used for each task.

Table 2.3 Achievement Conditions

TASK 1 WELD PIPING
Achievement Conditions
Work areas On the construction site or in the workshop, outdoors or indoors.
Sectors Civil engineering and roads; industrial; institutional and commercial.
Level of collaboration Alone and in a team. In collaboration with pipe welders and pipe fitters, and at times with refrigeration mechanics and boiler makers. Under the foreman’s supervision.

TASK 1 WELD PIPING

Achievement Conditions

Instructions and references

Based on welding procedures, waybills and contractor instructions.

According to the Regulation respecting pressure vessels and to standards such as ASME B31.3, CSA Z662, etc.

Types of metals used

Mild steel, stainless steel, chrome steel, nickel, copper, titanium, Inconel, Monel and other alloys.

Health and safety hazards

In a context that involves hazards of:

- electricity;
- electrification;
- explosion;
- inert gas poisoning;
- smoke poisoning;
- weather conditions;
- working in shoring cages;
- working in enclosed spaces;
- particles being projected in the eyes and face;
- arc strikes;
- backache;
- hand injuries;
- knee problems;
- cervical pain;
- carpal tunnel syndrome;
- falling;
- falling parts;
- cuts;
- burns;
- jamming and crushing;
- industrial process characteristics.

TASK 2 REPAIR WELDING WORK

Achievement Conditions

Work areas

On the construction site, outdoors or indoors.

Sectors

Civil engineering and roads; industrial; institutional and commercial.

Level of collaboration

Alone and in a team.
Under the foreman's supervision.

Instructions and references

Based on non-destructive test reports and on the repair procedure.
Based on the client's instructions.
According to the Regulation respecting pressure vessels and to standards such as ASME B31.3, CSA Z662, etc.

Types of metals used

Mild steel, stainless steel, chrome steel, nickel, copper, titanium, Inconel, Monel and other alloys.

Health and safety hazards

In a context that involves hazards of:

- electricity;
- electrification;
- explosion;
- inert gas poisoning;
- smoke poisoning;
- weather conditions;
- working in shoring cages;
- working in enclosed spaces;
- particles being projected in the eyes and face;
- arc strikes;
- backache;
- hand injuries;
- knee problems;
- cervical pain;
- carpal tunnel syndrome;
- falling;
- falling parts;
- cuts;
- burns;
- jamming and crushing;
- industrial process characteristics.

TASK 3 PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS

Achievement Conditions

Work areas

On the construction site and in the workshop, outdoors or indoors.

Sectors

Civil engineering and roads; industrial; institutional and commercial.

Level of collaboration

Alone and in a team.

In collaboration with pipe welders and pipe fitters, and at times with refrigeration mechanics and boiler makers.

Under the foreman's supervision.

Instructions and references

Based on the manufacturing plan or drawing, welding procedures, waybills and contractor instructions.

According to the Regulation respecting pressure vessels and to standards such as ASME B31.3, CSA Z662, etc.

Types of metals used and products

Mild steel, stainless steel, chrome steel, nickel, copper, titanium, Inconel, Monel and other alloys.

Degreasing products.

Health and safety hazards

In a context that involves hazards of:

- electricity;
- electrification;
- explosion;
- inert gas poisoning;
- smoke poisoning;
- weather conditions;
- working in shoring cages;
- working in enclosed spaces;
- using degreasing products;
- particles being projected in the eyes and face;
- arc strikes;
- backache;
- hand injuries;
- knee problems;
- cervical pain;
- carpal tunnel syndrome;

TASK 3 PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS
Achievement Conditions
• falling; • falling parts; • cuts; • burns; • jamming and crushing; • industrial process characteristics.

2.3.2 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 full session.

Table 2.4 Performance Criteria

TASK 1 WELD PIPING	
Performance Criteria	
Appropriate choice and use of tools	Appropriate choice of the filler metal or the type of wire to use
Wearing the personal protective equipment	Adequate body positioning
Teamwork ability	Mastering the welding process
Resistance to stress	Mastering the various welding positions
Correctly interpreting the welding procedure	Meticulous visual inspection of welding work
Preparing the work area according to weather conditions and contamination requirements	Following the welding procedure
Correct adjustment of welding parameters in the course of the work	Complying with standards and regulations
Preparing parts correctly	Complying with occupational health and safety rules

TASK 2 REPAIR WELDING WORK	
Performance Criteria	
Appropriate choice and use of tools	Preparing parts correctly
Wearing the personal protective equipment	Appropriate choice of the filler metal or the type of wire to use
Teamwork ability	Adequate body positioning
Resistance to stress	Mastering the welding process
Correctly interpreting the results of non-destructive tests	Mastering the various welding positions
Correctly interpreting the welding procedure	Meticulous visual inspection of welding work
Precisely locating the area to be repaired	Following the welding procedure
Preparing the work area according to weather conditions and contamination requirements	Complying with standards and regulations
Correct adjustment of welding parameters in the course of the work	Complying with occupational health and safety rules
Appropriate use of measuring instruments	
TASK 3 PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS	
Performance Criteria	
Appropriate choice and use of tools	Appropriate choice of the filler metal or the type of wire to use
Wearing the personal protective equipment	Adequate body positioning
Teamwork ability	Mastering the welding process
Resistance to stress	Mastering the various welding positions
Correctly interpreting manufacturing plans and drawings	Welding points of appropriate dimensions for the types of parts
Correctly interpreting the welding procedure	Solid welding points
Preparing the work area according to weather conditions and contamination requirements	Following the welding procedure
Correct adjustment the welding parameters	Complying with standards and regulations
Using measuring instruments appropriately	Complying with occupational health and safety rules
Putting parts in place according to welding procedures	

2.4 FUNCTIONS

Functions:

- are a set of interrelated tasks;
- may be defined by the work's results or by a procedure;
- are natural and concrete sets.

For the specialized occupation of pipe welder (high pressure), the workshop participants consider that the tasks cannot be grouped by affinities.

3. QUANTITATIVE DATA ON TASKS

3.1 OCCURRENCE

Occurrence data concern the percentage of pipe welders (high pressure) who perform a task in the same work environment. The data presented in the tables below are the average results of the participants. However, they account for tasks performed not only by the pipe welders attending the workshop, but also by all pipe welders working in the companies represented.

Table 3.1 Task Occurrence

Task	Occurrence
1 Weld piping	97.0%
2 Repair welding work	85.4%
3 Participate in prepairing and assembling parts	73.3%

3.2 WORK TIME

Work time, expressed below in percentages, represents the average time allocated to each task by each participant, on an annual basis.

Table 3.2 Allocation of Work Time to Tasks

Task	Work Time
1 Weld piping	68.0%
2 Repair welding work	7.8%
3 Participate in prepairing and assembling parts	24.2%

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, an unsatisfactory result, minor injury or accident hazards, etc.
3. Important: Poor execution of the task could lead to substantial additional costs, injuries, accidents, etc.
4. Very important: Poor execution of the task could lead to 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 occupation.

The data presented in the table below are the average results provided by the pipe welders who attended the workshop.

Table 3.3 Importance and Difficulty of Tasks

Task	Importance	Difficulty
1 Weld piping	4	2.6
2 Repair welding work	4	3.5
3 Participate in prepairing and assembling parts	4	1.9

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 specialized occupation.

4.1 KNOWLEDGE

Plan reading knowledge

Pipe welders consult manufacturing plans and drawings to produce parts such as supports and anchors, and they use structural plans to plan their work and detect joints to be welded or repaired.

Knowledge of materials

The occupation requires knowledge of materials. This knowledge pertains to the types of alloys, the characteristics of ferrous and non-ferrous metals, and the behaviours of metals during welding operations.

Knowledge of materials is useful – for example, for:

- understanding the nature of the work;
- interpreting and following welding procedures;
- taking measurements to prevent warping;
- choosing the filler metal;
- understanding the influence of weather on the quality of welding work;
- preventing contamination;
- interpreting the results of non-destructive tests;
- choosing the repair strategy;
- determining the tacking length and sequence.

Knowledge of quality control and non-destructive tests

Non-destructive tests may reveal welding defects such as lack of fusion, porosity, contamination, etc. Pipe welders must be able to understand the meaning of those tests and interpret tolerances, in order to choose the appropriate repair strategy and make repairs.

Knowledge of quality control is essential for complying with standards and regulatory requirements for welding on pressure vessels.

Knowledge of manual machining

Pipe welders perform certain manual machining tasks (cutting, shaping, folding, bending, drilling, chipping and threading) and preparation tasks (grinding, trimming, sanding, brushing, chamfering and filing) on parts when participating in preparation and assembly and when cleaning joints between welding passes (operation 1.9).

Knowledge of electricity

Electrical concepts regarding current intensity, voltage, polarity and grounding enable welders to use correct electric cable gauges and to check and adjust the welding equipment’s operation.

Occasionally, welders must use different frequency modulations to do certain types of welding work.

Electromagnetic concepts are also useful for preventing static discharges and reducing the influence of magnetic fields.

Knowledge of mathematics

Knowledge of mathematics is useful for:

- taking measurements;
- converting units of measurement;
- producing chamfer angles;
- adjusting filler metal angles;
- calculating travel speeds as well as gas volumes and flowrates.

Knowledge regarding the use of measuring and layout instruments

Knowledge regarding the use of measuring and layout instruments is useful for preparing and assembling parts, locating welding defects and checking welding work.

4.2 SKILLS

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

4.2.1 COGNITIVE SKILLS

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

Problem-solving

Problem-solving skills apply in many situations encountered in the occupation. Those skills are used, for example, when the pipe welder must:

- suggest solutions during assembly and installation operations;
- determine the welding procedure;
- help a colleague with difficult welding work;
- detect problems and make necessary corrections when making welding passes;
- repair welding work.

Planning activities

Planning skills are useful for practicing the occupation, because pipe welders must meet demanding performance and work quality requirements. In addition, pipe welders must cope with tight deadlines.

Planning activities is particularly important for establishing the welding procedure and determining the body positions to adopt according to the available space.

Decision-making

Decision-making skills apply, for example, when the pipe welder:

- requests corrections after inadequate assembly;
- corrects welding passes that present anomalies;
- exercises his right to refuse work that poses occupational health and safety hazards.

4.2.2 MOTOR SKILLS

Motor skills involve gestures and movements. The main motor skills that pipe welders need are dexterity, coordination and physical strength.

The work requires great manual dexterity. The pipe welder's gestures must be precise in order to execute oscillating movements and control the weld puddle, the penetration and the travel speed. According to the workshop participants, quality welding requires an absence of trembling, and ambidexterity is an asset.

Coordination is also important, because the pipe welder must simultaneously move, supply the weld puddle with filler metal and control the welding gun. Moreover, in confined spaces he sometimes uses a mirror to do welding work.

Lastly, pipe welders lift, carry or move loads of up to 50 kilograms.

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 pipe welders need are the following:

- excellent visual acuity, to perceive welding defects;
- good hearing, to detect occupational health and safety hazards and problems with penetration, reverse polarity and electrodes;
- good peripheral vision, to detect occupational health and safety hazards;

- good tactile skills, to maintain welding positions, control the travel speed and check welding quality;
- the skill to perceive objects in reverse view, in order to weld while using a mirror.

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 that pipe welder need are the following:

Personal attitudes

Pipe welders must demonstrate patience, rigour, attention to detail and concentration.

Interpersonal attitudes

Pipe welders work in collaboration with other welders, foremen, pipe fitters and inspection personnel. They must be able to respect their colleagues and communicate information appropriately.

In some situations, if pipe installation and welding risk causing execution errors, pipe welders have to be diplomatic in requesting changes to the installation procedure.

Professional ethics

A pipe welding error in pressure vessels can have major consequences for the safety of persons. So pipe welders must have good professional ethics and ensure an irreproachable execution complying with standards and procedures in effect.

Preventive attitudes and behaviours regarding health and safety

Preventive attitudes and behaviours regarding health and safety are observed, for example, when pipe welders:

- wear safety equipment;

- use appropriate welding shields, notably air cartridge masks, air purifying masks and masks with an active electro-optical filter;
- analyse hazardous situations and delimit the work space accordingly;
- put the protective equipment in place (canvases and screens);
- refuse to do dangerous work.

Welding operations require great concentration, and wearing a welding shield often isolates the pipe welder from his surroundings. This situation causes work accidents. Pipe welders must therefore be able to refocus their attention in order to prevent accidents.

5. TRAINING SUGGESTIONS

The persons attending the occupational analysis workshop made suggestions on the school training, on-the-job training and professional development of pipe welders.

With regard to school training, several participants made the following suggestions:

- focus the ASP training on mild and stainless steel welding, by using the SMAW and GTAW process, instead of teaching, as is currently done, numerous welding processes on numerous types of metals;
- adapt the welding and fitting study program to the realities of the construction industry;
- plan learning sessions on sanitary piping;
- offer the program in a work-study format;
- structure the learning according to the levels of difficulty related to processes, types of metal and positions.

As for on-the-job training of pipe welders, all the participants asked for recognition of the specialized occupation as a trade, so that learning periods are established to develop the skills of persons at the beginning of their careers.

Lastly, regarding the professional development of pipe welders, the participants suggested the following:

- offer courses in plan reading, in new technologies [for example, pulsed arc welding or the GMAW process of surface tension transfer (STT)] and in types of alloys (Inconel, titanium, aluminum, notably);
- define training durations more realistically;
- offer training that enables pipe welders to refresh their knowledge of certain processes.

Annexes

Annex 1
Tools and Equipment

For each task of the specialized occupation of pipe welder (high pressure) and according to a list submitted to them, the participants determined the tools and equipment they use: hand tools; layout, measuring and testing tools; power tools and equipment; rigging, hoisting and lifting equipment; access equipment; personal protective equipment and safety equipment; cutting, gouging, purging and welding equipment.

Table A.1 Tools and Equipment

TASK 1 WELD PIPING	
Hand Tools	
Magnet	Flashlight
Broom	Files (flat, half-round, rat-tail)
Clamps	Metal marker
Friction lighter	Steatite marker
Brushes (wire brushes, paint brushes)	Hammers (welder's, chipping, ball peen, claw, sledge)
Wood shims (dogs or mitres)	Mirror
Cylinder trolley	Tip cleaner
Chisels (cold, taper keys)	Stamping tools
Adjustable wrenches (of various sizes)	Shovel
Pipe wrenches	Pliers (needle nose, MIG, slip joint)
Hex wrenches (metric and imperial)	Chain pliers
Toolbox	Vise-grip pliers
Pipe cutters	Punches (centre punches, prick punches)
Knives	Rollers
Hand truck	Hacksaw
Vises (bench, chain)	Metal pails
Scrapers (of various sizes)	C-clamps
Pipe wrap	Screwdrivers (flat, Phillips, Torx, Allen Drivers, Robertson, of various sizes)
Wrench sets (open and closed ends; both metric and imperial)	Water hose
Socket sets (metric and imperial)	Hydraulic jack

TASK 1 WELD PIPING	
Layout, Measuring and Testing Tools	
Ammeter	Bubble level
Calculator	Laser level
Callipers	Torpedo level
Temperature sticks	Spacing tools
Combination squares	Vernier callipers
Plumb bob	Scribers
Spacer gauge	Pyrometer
Thickness gauge	Straight edges
Levelling gauge	Measuring tape
Power Tools and Equipment	
Portable heating unit	Grinders (die, bench, pedestal, angle)
Vacuum (dry/wet)	Drills (portable, hammer, electric, mag)
Rosebud tip torch	Polishing tool
Propane torch (tiger torch)	Sander
Compressor	Electric or pneumatic hacksaw
Extension cord	Circular saw
Hole saw	Air hose and nozzle
Coil heating equipment	
Rigging, Hoisting and Lifting Equipment	
Chain	Shackles
Jackstand	Chain block hoist
Forklift or telescoping lift truck	Overhead hoist
Rope	Come-along (cable or chain)
Slings	Spreader bar
Loop slings	Sling protector
Dunnage (blocking)	Cable clamps
Portable boom	Hand winch
Cranes (overhead, gantry-type, monorail, boom)	Tugger
Access Equipment	
Access bench	Crane nacelles and baskets
Scaffoldings	Elevated work platform
Ladders and stepladders	Scissor lift

TASK 1 WELD PIPING	
Personal Protective Equipment and Safety Equipment	
Air/gas monitoring device	Oxygen cutting goggles
Boots	Goggles
Hoods	Sleeves
Air hoods	Heat insulation sleeves
Hard hat	Leather coats
Coveralls	Welding shield
Fire blanket	Air welding helmet
Portable detectors	Mask with an active electro-optical filter
Face shield	Masks (particle, vapour)
Fire extinguisher	Ear-plugs and ear muffs
Gloves	Elbow pads
Knee pads	Respirator
Body harness / lanyards	Apron
Safety glasses	Fire hose
Cutting, Gouging, Purging and Welding Equipment	
Supply hoses	Pressure gauges
Welding lead	Welding guns (GMAW and FCAW)
Torches	Electrode holders (SMAW)
Plasma console	Pipe positioner
Flowmeter	Ground clamp
Oxy-fuel cutting and welding equipment	Cable connector
Electrode oven (SMAW, GMAW and FCAW)	Regulators
Arc welding machine	Wire feeders (GMAW, FCAW and SAW)

Communication device (two-way radio, cell phone)

TASK 2 REPAIR WELDING WORK	
Hand Tools	
Magnet	Files (flat, half-round, rat-tail)
Broom	Metal marker
Clamps	Steatite marker
Friction lighter	Hammers (welder's, chipping, ball peen, claw, sledge)
Brushes (wire brushes, paint brushes)	Mirror
Cylinder trolley	Tip cleaner
Chisels (cold, taper keys)	Stamping tools
Adjustable wrenches (of various sizes)	Shovel
Pipe wrenches	Pliers (needle nose, MIG, slip joint)
Hex wrenches (metric and imperial)	Chain pliers
Toolbox	Vise-grip pliers
Pipe cutters	Punches (centre punches, prick punches)
Knives	Rollers
Hand truck	Hacksaw
Vises (bench, chain)	Metal pails
Scrapers (of various sizes)	C-clamps
Pipe wrap	Screwdrivers (flat, Phillips, Torx, Allen Drivers, Robertson, of various sizes)
Wrench sets (open and closed ends; both metric and imperial)	Water hose
Socket sets (metric and imperial)	Hydraulic jack
Flashlight	
Layout, Measuring and Testing Tools	
Ammeter	Levelling gauge
Calculator	Bubble level
Callipers	Laser level
Temperature sticks	Torpedo level
Squares	Vernier callipers
Combination squares	Combination squares
Plumb bob	Pyrometer
Depth gauge	Straight edges
Spacer gauge	Measuring tape
Thickness gauge	

TASK 2 REPAIR WELDING WORK	
Power Tools and Equipment	
Portable heating unit	Grinders (die, bench, pedestal, angle)
Vacuum (dry/wet)	Drills (portable, hammer, electric, mag)
Rosebud tip torch	Polishing tool
Propane torch (tiger torch)	Sander
Compressor	Electric or pneumatic hacksaw
Extension cord	Circular saw
Hole saw	Air hose and nozzle
Coil heating equipment	
Rigging, Hoisting and Lifting Equipment	
Jackstand	Shackles
Forklift or telescoping lift truck	Chain block hoist
Rope	Overhead hoist
Slings	Come-along (cable or chain)
Loop slings	Spreader bar
Dunnage (blocking)	Cable clamps
Portable boom	Hand winch
Cranes (overhead, gantry-type, monorail, boom)	Tugger
Access Equipment	
Access bench	Crane nacelles and baskets
Scaffoldings	Elevated work platform
Ladders and stepladders	Scissor lift
Personal Protective Equipment and Safety Equipment	
Air/gas monitoring device	Oxygen cutting goggles
Boots	Goggles
Hoods	Sleeves
Air hoods	Heat insulation sleeves
Hard hat	Leather coats
Coveralls	Welding shield
Fire blanket	Air welding helmet
Portable detectors	Mask with an active electro-optical filter
Face shield	Masks (particle, vapour)
Fire extinguisher	Ear-plugs and ear muffs
Gloves	Elbow pads
Knee pads	Respirator
Body harness / lanyards	Apron
Safety glasses	Fire hose

TASK 2 REPAIR WELDING WORK	
Cutting, Gouging, Flushing and Welding Equipment	
Supply hoses	Arc welding machine
Welding lead	Pressure gauges
Torches	Electrode holders (SMAW)
Plasma console	Pipe positioner
Flowmeter	Ground clamp
Oxy-fuel cutting and welding equipment	Cable connector
Electrode oven (SMAW)	Regulators

Communication device (two-way radio, cell phone)

TASK 3 PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS	
Hand Tools	
Magnet	Lever
Broom	Files (flat, half-round, rat-tail)
Clamps	Metal marker
Friction lighter	Steatite marker
Brushes (wire brushes, paint brushes)	Hammers (welder's, chipping, ball peen, claw, sledge)
Cylinder trolley	Mirror
Chisels (cold, taper keys)	Tip cleaner
Adjustable wrenches (of various sizes)	Stamping tools
Pipe wrenches	Shovel
Hex wrenches (metric and imperial)	Pliers (needle nose, MIG, slip joint)
Toolbox	Chain pliers
Pipe cutters	Vise-grip pliers
Knives	Punches (centre punches, prick punches)
Trolly	Rollers
Vises (bench, chain)	Hacksaw
Scrapers (of various sizes)	Metal pails
Pipe wrap	C-clamps
Wrench sets (open and closed ends; both metric and imperial)	Screwdrivers (flat, Phillips, Torx, Allen Drivers, Robertson, of various sizes)
Socket sets (metric and imperial)	Water hose
Flashlight	Hydraulic jack
Layout, Measuring and Testing Tools	
Ammeter	Depth gauge
Calculator	Bubble level
Callipers	Laser level
Temperature sticks	Torpedo level
Squares	Spacing tools
Combination squares	Vernier callipers
Plumb bob	Scribers
Spacer gauge	Pyrometer
Thickness gauge	Straight edges
Levelling gauge	Measuring tape

TASK 3 PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS	
Power Tools and Equipment	
Reamer (hand held or mounted on power threader)	Pipe bevelling machine
Portable heating unit	Grinders (die, bench, pedestal, angle)
Vacuum (dry/wet)	Drills (portable, hammer, electric, mag)
Rosebud tip torch	Polishing tool
Propane torch (tiger torch)	Sander
Impact wrenches (electric or pneumatic)	Hydraulic press brake
Compressor	Electric or pneumatic hacksaw
Extension cord	Band saw
Pipe cutters	Chop saw (cut-off saw)
Hole saw	Reciprocating saw
Coil heating equipment	Circular saw
Nibbler	Orbital saw
	Air hose and nozzle
Rigging, Hoisting and Lifting Equipment	
Chain	Shackles
Jackstand	Chain block hoist
Forklift or telescoping lift truck	Overhead hoist
Rope	Come-along (cable or chain)
Slings	Spreader bar
Loop slings	Sling protector
Dunnage (blocking)	Cable clamps
Portable boom	Hand winch
Cranes (overhead, gantry-type, monorail, boom)	Tugger
Access Equipment	
Access bench	Crane nacelles and baskets
Scaffoldings	Elevated work platform
Ladders and stepladders	Scissor lift

TASK 3 PARTICIPATE IN PREPAIRING AND ASSEMBLING PARTS	
Personal Protective Equipment and Safety Equipment	
Air/gas monitoring device	Oxygen cutting goggles
Boots	Goggles
Hoods	Sleeves
Air hoods	Heat insulation sleeves
Hard hat	Leather coats
Coveralls	Welding shield
Fire blanket	Air welding helmet
Portable detectors	Mask with an active electro-optical filter
Face shield	Masks (particle, vapour)
Fire extinguisher	Ear-plugs and ear muffs
Gloves	Elbow pads
Knee pads	Respirator
Body harness / lanyards	Apron
Safety glasses	Fire hose
Cutting, Gouging, Purging and Welding Equipment	
Supply hoses	Pressure gauges
Welding lead	Welding guns (GMAW and FCAW)
Torches	Electrode holders (SMAW)
Plasma console	Pipe positioner
Flowmeter	Ground clamp
Oxy-fuel cutting and welding equipment	Cable connector
Electrode oven (SMAW, GMAW and FCAW)	Regulators
Arc welding machine	Welding heads (GMAW and FCAW)

Communication device (two-way radio, cell phone)

Annex 2

Matrix of Occupational Health and Safety Hazards

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Table A.2 Occupational Health and Safety Hazards for the Pipe Welder (High Pressure) Occupation

No.	Hazards	Effects on Health and Safety	Means of Prevention
1	**Electrical Hazards and Dangers**		
1a)	• Contact with live elements of the electrode holder, welding gun, and defective or poorly maintained electrical equipment	• Electrification • Fibrillation • Burns • Amputation • Paralysis • Electrocution • Falling	• Avoid any contact of skin or wet clothing with a live metal part. • Wear dry welding gloves. • Wear work boots with rubber soles or made of dry, non-conductive materials. • Do not route welding cables in wet locations. The electrode holders and power unit must remain dry. • Do not use electrode holders or guns cooled by water circulation unless they are perfectly sealed. • Do not use welding cables that have damaged connections, conductors or insulation. Cables must not be overloaded. • Use a sufficient section ground wire and connect it to the part to be welded as close as possible to the work area.
1b)	• Contact with an overhead electric line • Electric tools • Contact with electric wires or outlets • Contact with a live electric device or conduits in ceilings	• Electrification • Fibrillation • Burns • Amputation • Paralysis • Electrocution • Falling	• Maintain the minimum distances of approach prescribed by the Safety Code for the construction industry. • Use tools featuring double insulation or grounding. • Use extension cords in good condition and ground protection. • Apply a lockout procedure. • Train the workers in the lockout procedure in effect. • Took the compulsory training for working near electric lines. • Inspect power devices (wires) and tools according to manufacturer recommendations.

No.	Hazards	Effects on Health and Safety	Means of Prevention
2	**Radiation** • Ultraviolet and infrared emissions from the welding arc	• Skin burns and eye irritation	• At all times in work areas, wear protective goggles with side shields. • Wear a welding shield or use a hand shield equipped with a filter. • For skin protection, wear protective clothing against radiation, flames, electric discharges and sparks.
3	**Burns** • Burns from contact with a burning part, sparks or weld metal projections	• Burns • Fire • Explosion	• See the means of burn prevention listed in point 2. • Eliminate all fire or explosion hazards. • Ensure that the fire extinguishing equipment (pail of water, fire hose or portable fire extinguisher) is ready for use and accessible to the welders. • Remove flammable debris. The work area must be clean. • Wet the work area. • Cover combustible surfaces. • Control the sparks. • Rely on a fire watcher.
4	**Smoke** • Smoke from welding and cutting operations	• Malaise and temporary disorder • Decreased lung capacity	• Ensure good general exhaust ventilation. • Ensure that the respiratory tracts are protected by protective breathing masks with filters and with or without assisted ventilation.
5	**Welding gases** • Gases produced by welding and cutting	• Respiratory tract irritation • Dizziness • Poisoning from the decomposition products of coatings (such as paints, solvents, etc.) • Death by asphyxiation if oxygen is lacking in an enclosed space	• Ensure good general exhaust ventilation. • Ventilate enclosed spaces by fresh air intake and exhaust ventilation. • Clean the base metal while removing coatings. • Know the contaminants as well as the gases released by base metals (mild steel, aluminum, galvanized steel, etc.) and filler metals (wires and rods to be welded) when welding and cutting.

No.	Hazards	Effects on Health and Safety	Means of Prevention
6	**Explosive vapours and gases** • Explosive gas leak during oxygen cutting • Explosive vapours • Flammable liquids	• Explosion • Fire	• Maintain and use oxygas equipment adequately. • Ensure good general exhaust ventilation. • Ventilate enclosed spaces by fresh air intake and exhaust ventilation. • Apply protective procedures and means for hot work.
7 **7a)**	**Noise** • Noise from welding and cutting processes and equipment (except GTAW) • Considerable noise from cutting, air carbon arc gouging, and plasma jet processes (PA) • Noise from generator-powered welding stations and pulsed gas arc welding stations	• Hearing loss • Occupational deafness • Increased stress	• Move away or insulate sources of noise. • Wear hearing protectors and maintain them well. • Consult standard CAN/CSA-Z94.2 about hearing protection.
7b)	• Tools • Drilling for the anchors • Handling scaffoldings • Metal work	• Hearing loss • Occupational deafness • Increased stress	• Choose the quietest possible equipment. • Do the required preventive maintenance. • Plan the work in the construction site's less noisy areas. • Wear hearing protection (plugs or muffs).
8	**Same-level fall hazards** • Housekeeping (clutter, risk of tripping on obstacles such as rejects, debris, extension cords, pipes, materials) • Slippery surfaces (rain, ice, snow, residues, dust, oil) • Holes, uneven ground	• Collision • Contusion • Bruise • Fracture • Sprain	• Clean the work areas (pick up debris). • Protect the walking area or hang at 2.1 m any equipment that might constitute an obstacle. • Apply abrasives to make the surface less slippery. • Absorb oils and recover water. • Level the ground. • Plug the holes (fasten plywood).
9 **9a)**	**Fall-from-height hazards** • Using a stepladder	• Collision • Contusion • Bruise • Fracture • Sprain • Internal injury • Psychological and physical after-effects • Paralysis • Death	• Use a class 1 stepladder with a rated capacity of 113 kg (250 lb.) and: – keep the spreaders fully open; – install the stepladder on a firm level surface; – choose the stepladder according to the height to be reached; – keep the torso between the side rails.

No.	Hazards	Effects on Health and Safety	Means of Prevention
9b)	• Using a ladder	• Collision • Contusion • Bruise • Fracture • Sprain • Internal injury • Psychological and physical after-effects • Paralysis • Death	• Use a class 1 ladder. • Position and maintain a slope of 1/4 to 1/3 from the height of the bearing point. • Climb up and down a ladder while: – always having three support points; – holding the bars and not the side rails; – remaining between the side rails; – not holding anything in the hands; – facing the ladder.
9c)	• Using small mobile scaffolding	• Collision • Contusion • Bruise • Fracture • Sprain • Internal injury • Psychological and physical after-effects • Paralysis • Death	• Apply stability principles: – never exceed three times the smallest support base; – always use the wheel locking mechanism; – climb down a mobile scaffold to move it.
9d)	• Using metal frame scaffolding or tubular, socket and rosette scaffolding	• Collision • Contusion • Bruise • Fracture • Sprain • Internal injury • Psychological and physical after-effects • Paralysis • Death	• Stabilize the scaffold by: – using stabilizers on the ground; – tying it to the building; – using guys; – placing the two side rails side by side and fastening them by wind bracing. • When there is a risk of falling more than 3 metres install a railing system or be attached to a vertical lifeline complying with the specifications in the Safety Code for the construction industry. • Check the bearing capacity of the ground. • Install beds and jack screws if the ground is sloped or uneven. • For each scaffolding section, install vertical locks. • Use safe means of access. • Install anchors to the structure at intervals not exceeding three times the minimum scaffolding width. • Ensure that the planks are CSA certified, that the floor is wide enough (minimum 470 mm), that the distance between the structure and the floor is less than 350 mm, and that the load resistance is sufficient for the loads borne. • Inspect the scaffolding daily.

No.	Hazards	Effects on Health and Safety	Means of Prevention
9e)	• Using an aerial automotive work platform	• Collision • Contusion • Bruise • Fracture • Sprain • Electrical hazard • Internal injury • Poisoning • Psychological and physical after-effects • Paralysis • Death	• Took training in safe use as required by standards and manufacturers. • Wear an energy-absorbing harness for the jib boom platform. • Delimit the work area to avoid collision hazards and prevent objects from falling on other workers. • Keep the feet on the platform floor. • Climb up and down facing the equipment, while maintaining three support points. • Keep the platform accesses and floor clean. • Use a carbon monoxide detector in the case of a combustion appliance used indoors. • Lock hazardous energy sources during use (electrical conduit, live appliance, gantry, garage doors, etc.).
10	**Chemical Hazards and Dangers** • Insulation dust (mineral wool, fibreglass) • Silica dust • Asbestos dust • Cleaning solvent • Lubricant • Fuel for motorized devices • Mineral wool • Poisoning (carbon monoxide) • Asphyxia (lack of oxygen) • Gas leak • Projection of corrosive fluid	• Silicosis • Asbestosis • Mesothelioma • Lung cancer • Skin disorders (dermatitis) • Carbon monoxide poisoning • Sensitization • Corrosive burns • Eye injuries, blindness • Fire, explosion	• Took WHMIS training. • Have on-site the specification sheets of products used. • Use less-toxic products or wear PPE prescribed by the product manufacturer (eye protection, gloves, clothing, respirators). • Took asbestos training, as prescribed by the Safety Code, art. 3.23.7. • Be trained in the use of respiratory protection (masks and respirators) if required. • Wear respiratory protection and filters appropriate to contaminants. • Ensure mechanical or natural ventilation. • Wear safety goggles or a visor. • Use tools (e.g. drills, vacuum) equipped with a vacuum system including a HEPA filter. • Have emergency equipment at hand (eye-wash station, fire extinguisher, etc.). • Apply the lockout procedure.
11	**Ergonomic Hazards and Dangers** • Posture constraints / statis • Repetitive movements • Handling • Task difficulty • Weight and shape of tools • Vibrations (hand-arm system)	• Musculoskeletal lesions (shoulders, elbows, hand/thumb) • Sprains • Hernias • Fatigue, discomfort, pain • Tendinitis, carpal tunnel syndrome, etc. • Lower back pain • Neck pain	• Rotate tasks if the situation allows it (reduce repetitive movements). • Use handling equipment. • Know handling techniques. • Favour the purchase of tools limiting vibrations to a minimum. • Provide necessary backup lighting.

No.	Hazards	Effects on Health and Safety	Means of Prevention
12	**Mechanical Hazards and Dangers** • Moving parts • Breaking blade, bit or tool • Storage of materials • Superimposed work • Trench collapse • Falling object on an older installation	• Contusions • Fractures • Crushing • Amputation • Cuts • Falls • Concussion • Burial • Jamming • Crashing	• Comply with the regulatory grid regarding machine protection. • Do required preventive maintenance. • Collect information and take training in the use of new tools. • Apply the lockout procedure in effect. • Keep a work environment clean, without obstruction. • Prevent the fall of objects. • Eliminate any possibility of superimposed work. • Use shoring or observe the disengagement slopes in trenches. • Use a tool suitable for the task. • Use a tool in good condition.
13	**Environmental Hazards and Dangers** • Extreme temperature (cold or hot) • Enclosed space • Heat released by tools and equipment	• Discomfort due to cold • Chilblains • Hypothermia • Thermal stresses (heat) • Heat stroke • Burn	• Comply with health and safety rules. • Use a working method and personal protection ensuring protection against burns (water, carpet, gloves, etc.). • Train the workers to work in enclosed spaces. • Measure gases before each entry in an enclosed space. • Train the workers to work in enclosed spaces. • Ensure adequate ventilation of work areas. • Do preventive maintenance of gas equipment. • Take training in the hazards of carbon monoxide and nitrogen dioxide. • Alternate periods of work and rest. • Drink water.
14	**Stress-related Hazards and Dangers** • Unrealistic deadlines • Unforeseen events related to existing installations • Client requirements	• Health disorders • Hypertension • Eczema	• Plan the work. • Limit work done under stress.