

Blaster-driller

Occupational Analysis Report

January 2013



Commission
de la construction
du Québec

The purpose of this report is to describe as accurately as possible the blaster-driller occupation 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 in the occupation.

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.

The present 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 CCQ extends special thanks to the Commission de la santé et de la sécurité du travail and its representative, Mr. Lauréat St-Pierre, for their collaboration in producing the occupational health and safety grid appended to the present report.

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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 analyses¹ of all construction industry trades and specialized 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 booklets requiring a detailed description of each trade and specialized occupation;
- the fact that most construction occupational analyses² had been conducted between 1987 and 1991 and had not been reviewed since;
- updates to professional qualification examination question banks for trades;
- 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 and specialized occupations in Quebec.

The occupational analysis of the blaster-driller occupation belongs to this context³. Its purpose is to describe this specialized occupation as currently practiced in the construction industry. The present report was written in order to collate and organize the information gathered during the occupational analysis workshop held in Québec City on December 15 and 16, 2011.

This analysis aims to draw a portrait of the occupation (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 drillers and blasters. 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 “occupation” 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 OCCUPATION

According to the construction industry's civil engineering and road sector collective agreement 2010-2013, "shot-firer" (blaster) means:

"... Anyone who holds a valid shot-firer's certificate under the Act respecting occupational health and safety (R.S.Q., c. S-2.1), and performs all work governed by this Act."

The Safety Code for the construction industry mentions that the "shot-firer" (blaster) is:

"... Any person who carries out blasting or any work in which explosives are used."

(R.S.Q., 1981, c. S-2.1, r. 6, a. 4.2.1; D. 1959-86, a. 33; D. 1279-98, a. 1)

According to the construction industry's civil engineering and road sector collective agreement 2010-2013, "driller" means:

"... Anyone who operates a mobile or rail type self-powered drilling rig. "Self-powered drilling rig" means any drilling rig powered by a hydraulic or pneumatic force, whether the energy source is generated by equipment that is integrated or not to such rig."

The participants agreed with the definition. However, they made the following clarifications:

- the "drilling rig" is more generally called a "drill"⁴;
- to drills "powered by a hydraulic or pneumatic force" are added hand drills, which, although used less and less often, are still present;
- the definition presented for blasters could also represent the work of assistant blasters; the responsibilities of each should be distinguished more clearly.

4. "Drill" will therefore be used in the present report.

1.2 JOB TITLES

On construction sites, the titles “shot-firer,” “driller”, “rock blaster” and “shot-firer/driller” are used most often for referring to blaster-drillers. The title “blaster-driller,” translating the French title “boutefeu-foreur” used in the construction industry’s collective agreements, will nevertheless be used in the present report.

Blaster-drillers are occasionally confused with assistant blaster-drillers or with skilled labourers (who do drilling work to install anchors), some of whose tasks are at times similar to those of blaster-drillers.

1.3 SECTORS OF ACTIVITY

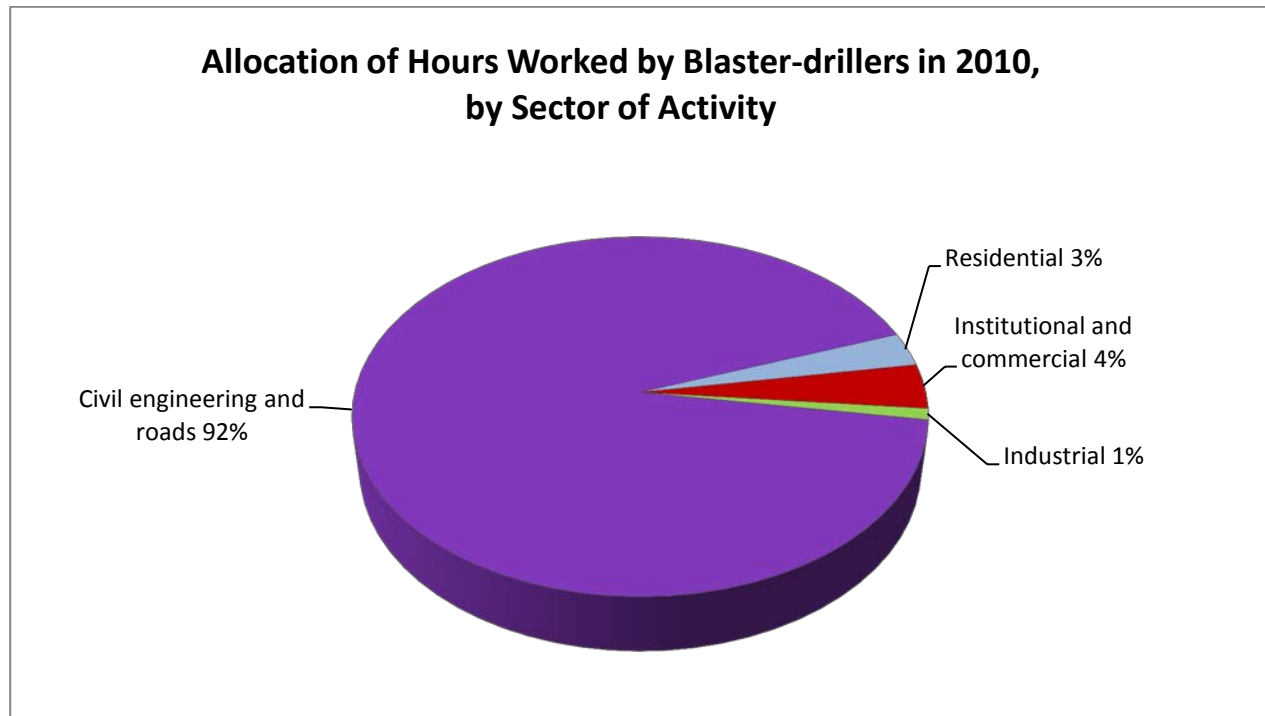
Blaster-drillers are active, to various degrees, in the four construction industry sectors:

- the residential sector;
- the industrial sector;
- the institutional and commercial sector;
- the civil engineering and roads sector.

The diagram below illustrates the work time allocation for all blaster-drillers in Quebec in 2010⁵.

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

Table 1.1 Workload of Blaster-drillers



After presenting the above diagram, we asked the participants' views about the sectors in which they practiced their occupation **in the last year**. The table below presents both the situation described by the blaster-drillers attending the workshop and that of all workers in the occupation.

Table 1.2 Work Time Allocated to Each Sector

Sector	Percentage of Work Time Allocated to Each Sector	
	All Blaster-drillers in Quebec	Blaster-drillers Attending the Workshop
Residential	3%	7.5%
Institutional and commercial	4%	—
Civil engineering and roads	92%	92.5%
Industrial	1%	—

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 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 LEGISLATION AND REGULATIONS

Blaster-drillers 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 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;
- federal and provincial regulations for transporting and handling explosives;
- regulations for work done near underground pipes (gas, electricity, etc.);
- environmental protection regulations;
- internal standards and regulations specific to client companies.

1.6 WORKING CONDITIONS⁶

The following information provides an overview of the conditions and context of the work of blaster-drillers, 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

The average annual salary of a blaster-driller having worked at least 500 hours in 2010 was \$63,594. 76% of blaster-drillers cumulated at least 500 hours.

As of May 1, 2011, a blaster-driller's daytime hourly wage was as follows:

	Industrial	Institutional and Commercial	Civil Engineering and Roads	Light Residential	Heavy Residential
Blaster	\$32.56	\$32.56	\$32.56	\$26.74	\$28.46
Driller	\$32.56	\$32.56	\$32.56	\$27.61	\$29.41

Vacations and time off

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 possibilities for changing the vacation periods prescribed by the general rule. To these vacation periods are added eight not worked statutory holidays, as well as a lump sum for sick leaves not otherwise paid.

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, occupation or sector.

6. The general data on working conditions are taken from the four collective agreements 2010-2013 of the construction industry sectors, and from the following document, published by the Commission de la construction du Québec: *Careers - Construction*, 2011-2012 edition.

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 requires being in good condition and having some physical strength. Blaster-drillers often have to lift and move substantial loads of 25 kg and more. Given that they work almost exclusively outdoors, they must endure harsh weather conditions (intense cold and heat, bad weather, etc.). The work days and weeks are often long, particularly for blasting work. Blaster-drillers must therefore have good fatigue resistance (particularly in remote areas). In addition, the work often takes place on steep, muddy and rough terrain, so blaster-drillers must have good balance and be able to move easily in all conditions. Finally, because working at a height is necessary in some cases, blaster-drillers suffering from vertigo would have difficulty performing certain tasks. However, vertigo is not an impediment to practicing the occupation.

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. Finally, in the civil engineering sector, the regular hours for several trades and types of work are 45 hours a week from Monday to Friday, with a daily limit of 9 to 10 hours.

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.

Near large urban areas, blaster-drillers generally work during weekdays and daytime, for a total of 45 hours. In remote areas, work weeks are longer (often 55 to 60 hours) and the work is done not only in the daytime, but also in the evening, and even at night.

Blaster-drillers working in the construction sector must be prepared to travel outside their area of residence, for relatively long periods.

1.7 JOB MARKET ENTRY CONDITIONS⁷

To practice the **blaster** occupation on a construction site, a worker must:

- be at least 18 years of age;
- hold a general explosives permit issued by the Sûreté du Québec;
- successfully pass the certification examination administered by the Commission de la construction du Québec on behalf of the Commission de la santé et de la sécurité du travail.

The conditions for admission to the examination are as follows:

- holding a vocational studies diploma (DEP) in drilling and blasting;
OR
 - having worked 150 hours as an assistant blaster in the last 24 months⁸;
- hold an occupation competency certificate issued by the CCQ. The conditions for obtaining that certificate, in addition to those listed above, are as follows:
 - having successfully passed the course *Santé et sécurité générale sur les chantiers de construction*;
 - having successfully passed the course *Cours de connaissance générale de l'industrie de la construction* (CCGIC).

To practice the **driller** occupation on a construction site, a worker 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 the course *Cours de connaissance générale de l'industrie de la construction* (CCGIC).

7. 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/E_CertificatsCompetence/E02_Apprenti/E02_3_CandidatDiplome.aspx?sc_lang=en&profil=GrandPublic.

8. The worker must provide a letter from his employer that certifies the hours worked as an assistant blaster and the worker's aptitude for working safely as a blaster. The worker must also provide all required documents.

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

- motivation, interest in the work to be done;
- experience in the type of work to be done;
- diligence;
- ability to cooperate with other workers and one's supervisors;
- reliability;
- punctuality.

Of the 12 workshop participants, 7 have obtained their DEP in drilling and blasting. The participants mentioned that this DEP, although an asset, is not considered absolutely mandatory by employers seeking a blaster-driller. However, they pointed out that generally, new blaster-drillers holding the DEP learn more quickly and thus adapt more quickly to work requirements than those without any training in the field.

1.8 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 CCQ⁹, in 2010, 7 women (out of a total of 663 blaster-drillers) were practicing the occupation, i.e., 1.06%.

According to the participants, the main factor that might explain the low presence of women in the occupation is the physical strength required for lifting substantial loads (handling pipes, loading holes, etc.). But drilling is reportedly considered less physically demanding than blasting work; this might be a solution for women who want to practice this occupation but are limited by the physical requirements.

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

1.9 CAREER PROSPECTS

With experience, blaster-drillers who want to can become team leaders, foremen and eventually supervisors. Some may choose to become contractors, private consultants or company instructors, or vocational teachers.

1.10 DEVELOPMENT OF THE OCCUPATION

Among the changes that have occurred in recent years, the following stand out:

- tighter application of regulations, particularly for work carried out in urban centres, near residences and infrastructures. Blaster-drillers must therefore know those regulations and ensure their strict application. Moreover, the participants mentioned that some of the laws governing blaster-drillers include obsolete and contradictory sections, thus complicating the work in some cases. Such sections should thus be updated;
- a focus on safety, given that the work of blaster-drillers is more and more supervised;
- the fact that blaster-drillers are more and more supervised by engineers. Accordingly, the participants note that more documents have to be filled out to report on the work done;
- the introduction of new drill accessories (remote control, emulsion pump, etc.);
- the appearance of electronic initiating systems;
- the use of new explosive products and equipment.

1.11 IMPACT OF ENVIRONMENTAL STANDARDS ON THE PRACTICE OF THE OCCUPATION

The application of environmental standards has an impact on the work of blaster-drillers, and that impact is expected to grow. More specifically, the participants mentioned the following effects:

- For blasting work done near streams or wooded areas, it is necessary to limit projections.
- Gas emissions must be controlled so as to avoid infiltrations and contaminations (of air, water, etc.).

- Recovering fluids (fuel residues, waste oil, etc.) has become common practice, so the blaster-driller has to change his practices somewhat.
- To avoid fluid contamination, the blaster-driller must be able to use containment material in case of a spill.
- Environmental protection concerns are more prevalent, whether in the choice of products (such as vegetable oil used for lubricating various machines) or of work methods.

So generally, the application of environmental standards requires planning the work more extensively, performing tasks more precisely and taking additional precautions, in order to avoid damaging or contaminating natural environments.

Regarding work done near urban centres, noises and vibrations must be controlled more and more tightly, which also requires the blaster-driller to take additional precautions.

2. WORK DESCRIPTION

2.1 TASKS AND OPERATIONS

The following list presents the main tasks performed by blaster-drillers. The order in which the tasks are presented does not necessarily reflect their importance in the occupation.

Drilling:

- | | |
|---------|---|
| Task 1 | Prepare the drilling |
| Task 2 | Organize the drilling |
| Task 3 | Inspect and maintain drilling equipment and accessories |
| Task 4 | Develop the drilling pattern |
| Task 5 | Mark the drilling points |
| Task 6 | Prepare the drill for the work |
| Task 7A | Drill with a pneumatic or hydraulic drill ¹⁰ |
| Task 7B | Drill with a “down the hole” drill |
| Task 7C | Drill with a hand-held air drill ¹¹ |
| Task 8 | Replace broken or stuck drill rods |
| Task 9 | Drill with a winch |

Blasting:

- | | |
|----------|---|
| Task 10 | Organize the blasting |
| Task 11 | Inspect and maintain the blasting equipment and accessories |
| Task 12A | Load the drill holes ¹² (electric initiation) |
| Task 12B | Load the drill holes (non-electric initiation, with or without a detonating cord) |
| Task 12C | Load the drill holes (electronic initiation) |
| Task 13 | Extend the lead wire |
| Task 14 | Fire the explosives |
| Task 15 | Inspect the blast area |

10. The drill may be conventional, remote controlled, with or without a cab, or underground.

11. Although still performed in some cases, this task is disappearing.

12. Nowadays, this task is performed only for very small jobs; it is disappearing.

The workshop participants confirm that all these tasks fully cover the drilling and blasting work done by blaster-drillers. However, for a given project, not all these tasks are always performed by a single person. Indeed, they are often assigned to two different persons: a driller who will perform drilling tasks (tasks 1 to 9) and a blaster who will perform blasting tasks (tasks 10 to 15). Thus, depending on the needs, the construction site's size, etc., blaster-drillers may act at times as drillers, at times as blasters, or be responsible for the joint tasks. But it should be noted that the legal requirements are not the same for the two functions – the person qualified for the blasting operations may perform the drilling tasks, but not the reverse (see section 1.7, “Job Market Entry Conditions,” in the present report).

During the workshop, a table of tasks and operations performed by blaster-drillers was submitted to the participants. Following discussions, changes were made to the table. The final version is presented in the following pages.

Table 2.1 Tasks and Operations

TASKS	OPERATIONS					
1 Prepare the drilling	1.1 Gather and check the personal protective and safety equipment	1.2 Receive instructions from one's supervisor (e.g.: drilling methods)	1.3 Select the equipment, tools and accessories	1.4 Make sure the selected materials work correctly, and check fuel levels	1.5 Fill out forms or write a report	1.6 Transport the drill
2 Organize the drilling	2.1 Receive instructions from the construction site superintendent	2.2 Make sure the ground has been prepared	2.3 Determine an access road	2.4 Lower the drill from the float	2.5 Organize the work area	2.6 Park the drill and equipment
	2.7 Give guidelines to the excavator operator					
3 Inspect and maintain drilling equipment and accessories	3.1 Make sure to have the necessary equipment and accessories	3.2 Check the drill's safety devices and accessories	3.3 Check the equipment's mechanical condition	3.4 Connect hoses and safety chains, if applicable, and ensure that the pipes are clean	3.5 Check the quantities of fuel and fluids	3.6 Start the equipment (compressor and drill)
	3.7 Check dials and indicators and detect leaks	3.8 Make sure the hammer is working correctly	3.9 Stop the machine and store the equipment	3.10 Report defects verbally and in writing	3.11 Organize fuel and fluid supplies	
4 Develop the drilling pattern	4.1 Receive instructions or read the plans	4.2 Examine the constraints of the ground	4.3 Determine the rock characteristics	4.4 Determine the drilling pattern's parameters	4.5 Produce a sketch of the drilling pattern	

TASKS	OPERATIONS					
5 Mark the drilling points	5.1 Adapt the drilling pattern to ground characteristics, if applicable	5.2 Measure and mark drilling parameters (burden and spacing) on the ground	5.3 Place mining exploration drill plugs ¹³			
6 Prepare the drill for the work	6.1 Move and install the compressor, if applicable	6.2 Direct the mast in relation to the ground	6.3 Position the drill	6.4 Stabilize the drill's drive mechanism	6.5 Screw the drill rod on the hammer	6.6 Check the drill bit's diameter
	6.7 Screw the drill bit and the coupling sleeve	6.8 Determine the drilling angle, if applicable, and position the mast	6.9 Check the mast's verticality or tilt angle			
7A Drill with a pneumatic or hydraulic drill	7.1A Lower the drill rod and start the rotation	7.2A Actuate the air control lever and the hammer	7.3A Adjust the drilling pressure and rotation speed according to the characteristics of the rock to be drilled	7.4A Actuate the dust collector or the water supply mechanism and make necessary adjustments	7.5A Check the mast's tilt angle regularly (particularly when drilling on sloping ground)	7.6A Monitor the normal evacuation of dust and drill chips
	7.7A Clean the drill hole, if necessary	7.8A Check the drill hole's depth	7.9A "Break" the drill rods	7.10A Raise the hammer and grease the threads	7.11A Install the upper coupling sleeve on the hammer, if applicable	7.12A Install the other drill rod(s)
	7.13A Open the centralizer	7.14A Repeat operations 7.1 to 7.7	7.15A Proceed with final flushing of the drill hole	7.16A Stop the drilling operations	7.17A Clean the drill hole's periphery	7.18A "Break" the drill rods

13. Mining exploration drill plugs are cones for covering holes after drilling, in order to protect them and thus prevent them from being blocked.

TASKS	OPERATIONS					
	7.19A Remove the drill rods	7.20A Move the mast and drill, according to the drilling pattern	7.21A Measure and note the drill hole's depth	7.22A Place mining exploration drill plugs	7.23A Mark and protect the drill hole	7.24A Regularly check the wear of the drill bit and drill rods
	7.25A Complete the drilling report					
7B Drill with a “down the hole” drill	7.1B Lower the hammer and drill rod and start the rotation	7.2B Actuate the air control lever and the hammer	7.3B Adjust the rotation and supply pressure according to the characteristics of the rock to be drilled	7.4B Check the mast's tilt angle regularly (particularly when drilling on sloping ground)	7.5B Actuate the dust collector or the water supply mechanism and make adjustments	7.6B Monitor that the dust and drill chips are being evacuated
	7.7B Clean the drill hole, if applicable	7.8B Check the depth of the drill hole	7.9B Unscrew the drill rod	7.10B Assemble the rotary and grease the threads	7.11B Install the second drill rod	7.12B Repeat operations 7.1B to 7.7B
	7.13B Proceed with final flushing of the drill hole	7.14B Ensure that the hole's depth corresponds to the drilling plan	7.15B Unscrew the second drill rod	7.16B Remove the drill rods	7.17B Measure and note the drill hole's depth	7.18B Mark and protect the drill hole
	7.19B Move the drill according to the drilling pattern	7.20B Regularly check the wear of the drill bit and drill rods	7.21B Clean the drill hole's periphery	7.22B Place mining exploration drill plugs ahead for the next drilling	7.23B Complete the drilling report	

TASKS	OPERATIONS					
7C Drill with a hand-held air drill	7.1C Install the air line	7.2C Install a lubricator on the air line and make sure it is effective	7.3C Choose drill rods	7.4C Make sure the drill bits have a similar diameter	7.5C Clean the drill hole's periphery	7.6C Insert the drill rods in the air hammer or jackhammer
	7.7C Actuate the drill and flush the hole regularly	7.8C Keep the drill at the required tilt angle	7.9C Replace the drill rod regularly and store it	7.10C Check the depth of the drill hole	7.11C Place mining exploration drill plugs	
8 Replace broken or stuck drill rods	8.1 Unscrew the drill rods (see 7.9B)	8.2 Remove the drill rods down to the break	8.3 Replace the upper part of broken drill rods and add extractors to them	8.4 Press the extractor on the lower part of broken drill rods	8.5 Apply slight pressure on the rotary	8.6 Actuate the air supply mechanism to extract dust
	8.7 Stop the air, if applicable	8.8 Raise and unscrew the lower part of drill rods up to the extractor	8.9 Remove the lower part of broken drill rods	8.10 Recover the hammer, if applicable	8.11 Replace the lower part of broken drill rods	
9 Drill with a winch	9.1 Check the condition of the cable and its attachments	9.2 Locate and drill tilted anchor points	9.3 Install anchors solidly in the rock and position the drill	9.4 Hang the winch cable to the anchor bolt	9.5 Ensure the strength of cables and attachments	9.6 Install pulleys, if applicable
	9.7 Lower the drill perpendicularly to the slope	9.8 Stabilize the drill's drive mechanism	9.9 Install an independent anchor to enable the driller to fasten his lifeline	9.10 Drill	9.11 Check the depth of the drilled hole	9.12 Place mining exploration drill plugs
	9.13 Use the winch to raise the drill to the top of the slope	9.14 Remove all anchors after the drill has been raised	9.15 Stabilize the drill before shut off			

TASKS	OPERATIONS					
10 Organize the blasting	10.1 Receive instructions from one's supervisor	10.2 Locate and inspect the work area	10.3 Find out about regulations specific to the work area, if applicable	10.4 Obtain the various necessary permits	10.5 Determine the location of magazines and install them	10.6 Display the permits
	10.7 Choose the types of explosives and the blasting accessories and place the order	10.8 Check the explosives and accessories received and store them in their respective magazines	10.9 Complete the inventory log	10.10 Install jobsite boxes	10.11 Install safety signs	10.12 Ensure the availability of measuring and verification instruments
11 Inspect and maintain the blasting equipment and accessories	11.1 Make sure to have the necessary equipment and accessories	11.2 Check firing accessories	11.3 Check the siren's operation	11.4 Check the placards	11.5 Make necessary corrections, if applicable	
12A Load the drill holes (electric initiation)	12.1A Inspect all drill holes	12.2A Identify the loading area	12.3A Transport the explosives	12.4A Place the explosives and accessories in the jobsite boxes	12.5A Develop the firing plan	12.6A Determine the loading sequence
	12.7A Distribute detonators according to the firing plan	12.8A Assemble the primer cartridge and insert it in the drill hole	12.9A Fill the hole with explosives up to the planned height	12.10A Check load continuity in the hole	12.11A Plug the hole with the mining exploration drill plug, if applicable	12.12A Complete the firing log

TASKS	OPERATIONS					
	12.13A Connect leg wires according to the firing plan	12.14A Balance the series of circuits according to the exploder's capacity	12.15A Check circuit continuity and calculate resistance ¹⁴	12.16A Remove the mining exploration drill plug and tamp the drill holes	12.17A Use a galvanometer to recheck the circuit	12.18A Isolate each exposed electrical connection
	12.19A If applicable, check each series of circuits and the entire firing plan	12.20A Ensure the safety of the blast area by assigning someone to monitor (in the blaster's absence)				
12B Load the drill holes (non-electric initiation, with or without a detonating cord)	12.1B to 12.12B Perform operations 12.1A to 12.12A	12.13B Tamp the drill holes	12.14B Extend the detonating cord and connect the shock tubes	12.15B Distribute and connect surface timers according to the firing plan	12.16B Check the entire circuit	12.17B Protect the surface connections, if applicable
	12.18B Ensure the safety of the blast area by assigning someone to monitor (in the blaster's absence)	12.19B Temporarily store surplus explosives in the jobsite boxes	12.20B Put blasting mats in place, if applicable	12.21B Install the seismograph at the designated location, if applicable	12.22B Store unused explosive products in their respective magazines	
12C Load the drill holes (electronic initiation)	12.1C to 12.12C Perform operations 12.1A to 12.12A	12.13C Tamp the drill holes	12.14C Identify the timers for each hole	12.15C Connect the electronic detonator to the main lead wire	12.16C Check the entire circuit	12.17C Protect surface connections by using the appropriate material, if applicable

14. According to the Safety Code for the construction industry (Division 4, section 4.6.9.1), when loading a blasthole, a protective buffer 100 mm thick must be inserted between the explosive load and the regular tamping. Otherwise, untamping the blasthole is strictly prohibited in all circumstances.

TASKS	OPERATIONS					
	12.18C Ensure the safety of the blast area by assigning someone to monitor (in the blaster's absence)	12.19C Temporarily store surplus explosives	12.20C Put blasting mats in place, if applicable	12.21C Install the seismograph at the designated location, if applicable	12.22C Store unused explosive products in their respective magazines	
13 Extend the lead wire	13.1 Delimit the safety perimeter and ensure that it is deserted	13.2 Determine the firing point and fully unroll the lead wire	13.3 Test the lead wire (open and closed)	13.4 Short-circuit the lead wire at the firing point	13.5 Return to the blast area and check the entire circuit	
14 Fire the explosives	14.1 Ensure that the blast area is fully evacuated	14.2 Connect the lead wire to the blast circuit	14.3 Check the exploder's load	14.4 Use the appropriate signals prior to firing	14.5 Connect the lead wire to the exploder	14.6 Proceed with firing
	14.7 Disconnect and short-circuit the exploder's lead wire	14.8 Observe the regulatory period before returning to the blast area	14.9 Store the exploder in a secure location			
15 Inspect the blast area	15.1 Assess the blast results	15.2 Find misfires, if applicable	15.3 Authorize traffic within the blast area	15.4 Roll up the lead wire	15.5 Empty the jobsite boxes	15.6 Recover the seismograph
	15.7 Conclude the firing log	15.8 Complete the waybill	15.9 Store surplus explosives in the magazine	15.10 Make an inventory of the explosives and complete the inventory log	15.11 Eliminate deteriorated explosives and the empty containers	

2.2 OPERATIONS, SUB-OPERATIONS AND CLARIFICATIONS

In the following pages are presented sub-operations related to most of the operations¹⁵, as well as a few clarifications made by the participants.

Table 2.2 Sub-Operations and Operation Clarifications

TASK 1: PREPARE THE DRILLING		
This task is performed before arrival on the construction site.		
Operations	Sub-Operations	Clarifications
1.1 Gather and check the personal protective and safety equipment		The protective equipment comprises, among other things, a hard hat, boots, gloves, glasses, a harness, a bid and, if necessary, hearing protection, etc.
1.2 Receive instructions from one's supervisor (e.g.: drilling methods)		The instructions may pertain to the following aspects: work method to be used, drilling location, type of rock, construction site superintendent, materials to take, approximate duration of the work, specific constraints, maximum depth, company responsible for fuel supplies, etc.
1.3 Select the equipment, tools and accessories		
1.4 Make sure the selected materials work correctly, and check fuel levels		Fluid (oil, grease, fuel, antifreeze) levels, filters, tension of the belts, hoses, tracks, the mast, etc. must be checked.
1.5 Fill out forms or write a report	1.5.1 Note the checkpoints 1.5.2 Record detected anomalies 1.5.3 Record the corrections made	Generally, the forms or report are forms to be checked. Those documents are completed during the inspection of materials and equipment (operation 1.4). In addition, the blaster-driller must notify the mechanic if he has detected an anomaly he cannot correct himself.

15. The sequence of operations may vary depending on the products and materials used.

TASK 1: PREPARE THE DRILLING

Operations	Sub-Operations	Clarifications
1.6 Transport the drill	1.6.1 Clean the drill 1.6.2 Prepare the drill for transportation 1.6.3 Load the drill and equipment on the float	Before each transportation on the road network, the drill must be cleaned and its mobile parts removed. A team with the float driver loads the drill.

TASK 2: ORGANIZE THE DRILLING

Operations	Sub-Operations	Clarifications
2.1 Receive instructions from the construction site superintendent		
2.2 Make sure the ground has been prepared		The terrain must be free of loose ground.
2.3 Determine an access road		The access road is used for moving drills and trucks. It must be safe.
2.4 Lower the drill from the float		This operation must be performed safely for the workers assigned to it. "Down the hole" drills with a large diameter may require a compressor to help move them.
2.5 Organize the work area	2.5.1 Locate the work area 2.5.2 Ensure that the depths to be drilled have been indicated on the site 2.5.3 Lay out the mini magazines and jobsite boxes	
2.6 Park the drill and equipment	2.6.1 Stop the drill and equipment 2.6.2 Clean the drill 2.6.3 Check any breakages 2.6.4 Proceed with greasing	
2.7 Give guidelines to the excavator operator		The guidelines pertain to access positions, the need to install mats, the location of jobsite boxes, etc.

TASK 3: INSPECT AND MAINTAIN DRILLING EQUIPMENT AND ACCESSORIES

Operations	Sub-Operations	Clarifications
3.1 Make sure to have the necessary equipment and accessories		
3.2 Check the drill's safety devices and accessories		The drill must be visually inspected so as to detect any anomaly: cracks, breakages, etc. The safety accessories are, for instance, fire extinguishers, absorbent layers (in case of a spill), emergency stop buttons on the drill, etc.
3.3 Check the equipment's mechanical condition		Filters, the tension of belts, hoses, tracks, the mast, etc. must be checked. The drill's mechanical components must be checked throughout the work.
3.4 Connect hoses and safety chains, if applicable, and ensure that the pipes are clean		
3.5 Check the quantities of fuel and fluids		
3.6 Start the equipment (compressor and drill)		
3.7 Check dials and indicators and detect leaks		
3.8 Make sure the hammer is working correctly	3.8.1 Check the blow pipe 3.8.2 Proceed with greasing 3.8.3 Detect oil leaks 3.8.4 Ensure that diaphragms are intact 3.8.5 Ensure that the oil distributor is in good condition 3.8.6 Ensure that the drill rod is intact	

TASK 3: INSPECT AND MAINTAIN DRILLING EQUIPMENT AND ACCESSORIES

Operations	Sub-Operations	Clarifications
3.9 Stop the machine and store the equipment	3.9.1 Ensure that the drill mast rests on the ground 3.9.2 Ensure that the on-off switch is off 3.9.3 Apply compressor manufacturer procedures	
3.10 Report defects verbally and in writing		
3.11 Organize fuel and fluid supplies		

TASK 4: DEVELOP THE DRILLING PATTERN

Operations	Sub-Operations	Clarifications
4.1 Receive instructions or read the plans		The plans are not always given to the blaster-driller. Often, the foreman consults the plans and tells the blaster-driller about the aspects that concern the latter. The surveyor may also give the blaster-driller instructions. However, when the foreman is not on the premises, the blaster-driller must be able to interpret the plans. These are mainly survey plans (positioning of holes, reference points, etc.).
4.2 Examine the constraints of the ground	4.2.1 Check for the presence of buildings, electric lines, streams, etc.	The constraints may pertain to the proximity of underground utilities, high-tension lines or buildings, or the necessity of controlling noise and vibrations, protect adjacent areas to avoid rock projections, etc.
4.3 Determine the rock characteristics	4.3.1 Check the rock composition 4.3.2 Check the rock hardness 4.3.3 Check for the presence of faults 4.3.4 Check for the presence of differences in level	The characteristics are determined by a visual inspection. However, at this stage the blaster-driller occasionally performs drill and blast tests to determine rock properties.

TASK 4: DEVELOP THE DRILLING PATTERN

Operations	Sub-Operations	Clarifications
4.4 Determine the drilling pattern's parameters		Drill pattern parameters depend, for example, on ground constraints, the depth required for holes, the type of explosives to be used, the volume to be dynamited, the rock size (fragmentation, granulometry) required for crushing, etc. The drill pattern presents, among other things, the positioning, spacing, depth and diameter of holes, the necessary load, the underdrilling to be done, etc. The participants mentioned that on the largest construction sites, the drill pattern must be approved by an engineer.
4.5 Produce a sketch of the drilling pattern		The sketch may be produced by the blaster-driller or a technician; it may be done freehand or by computer. In principle, a sketch of the drill pattern should always be produced. However, the participants mentioned that sometimes the blaster-driller gives the data verbally to the persons concerned (foreman, assistants, etc.).

TASK 5: MARK THE DRILLING POINTS

Operations	Sub-Operations	Clarifications
5.1 Adapt the drilling pattern to ground characteristics, if applicable		If the drill pattern has to be modified, the blaster-driller must inform his supervisor.
5.2 Measure and mark drilling parameters (burden and spacing) on the ground		The spacing between holes, the load (spacing between rows), the diameter of holes, the elevation to reach, etc. have to be measured and then marked on the rock, etc. Marking is done with aerosol paint; a template may be used for greater precision.

TASK 5: MARK THE DRILLING POINTS

Operations	Sub-Operations	Clarifications
5.3 Place mining exploration drill plugs		The participants mentioned that it may be necessary to add sleeves, for example on difficult terrain. At this stage, exploration drill plugs are laid out beside the locations where holes will be drilled; after drilling, the drill plugs will be placed on the holes.

TASK 6: PREPARE THE DRILL FOR THE WORK

Operations	Sub-Operations	Clarifications
6.1 Move and locate the compressor, if applicable	6.1.1 Choose an appropriate location 6.1.2 Position the compressor 6.1.3 Level the compressor 6.1.4 Place wheel blocks front and rear 6.1.5 Put the pipe in place	
6.2 Direct the mast in relation to the ground		
6.3 Position the drill	6.3.1 Examine the condition of the ground 6.3.2 Choose an appropriate location 6.3.3 Place the drill	
6.4 Stabilize the drill's drive mechanism		It is necessary to have the drill's leg rest solidly, if applicable, and to block the handles used for controlling drill movements.
6.5 Screw the drill rod on the hammer		The drill rod may be screwed manually, although the mechanical method is safer. The blaster-driller may take the opportunity to check the drill rod's wear.
6.6 Check the drill bit's diameter		

TASK 6: PREPARE THE DRILL FOR THE WORK

Operations	Sub-Operations	Clarifications
6.7 Screw the drill bit and the coupling sleeve		The blaster-driller may take the opportunity to check the drill bit's wear.
6.8 Determine the drilling angle, if applicable, and position the mast		Most of the time, the drilling angle is 90°. Occasionally it has already been determined and the blaster-driller does not have to perform this operation.
6.9 Check the mast's verticality or tilt angle		The verification is made using a protractor, a level (hand or integrated in the drill) or, more rarely, a plumb line.

TASK 7A: DRILL WITH A PNEUMATIC OR HYDRAULIC DRILL

Operations	Sub-Operations	Clarifications
7.1A Lower the drill rod and start the rotation		
7.2A Actuate the air control lever and the hammer		
7.3A Adjust the drilling pressure and rotation speed according to the characteristics of the rock to be drilled		The rotation speed and the pressure on the hammer should be reduced when the mast is tilted or when drilling on fissured ground.
7.4A Actuate the dust collector or the water supply mechanism and make necessary adjustments		The condition of filters and the dust collector's hose should be checked for the presence of stones or silt, or of air leaks that would hinder the drill's operation. Cleaning is done if foreign bodies are detected.

TASK 7A: DRILL WITH A PNEUMATIC OR HYDRAULIC DRILL

Operations	Sub-Operations	Clarifications
7.5A Check the mast's tilt angle regularly (particularly when drilling on sloping ground)		Most of the time, it is necessary to ensure that the drilling angle remains at 90° (see the clarifications on operation 6.8). The verification is made using a protractor, a level (hand or integrated in the drill) or, more rarely, a plumb line. The mast's tilt angle is checked mainly when drilling is done on sloping ground. The greasing of threads should also be checked during the operation and any necessary corrections should be made.
7.6A Monitor the normal evacuation of dust and drill chips		It is necessary to examine the drill chips to detect eventual changes in rock characteristics and react accordingly.
7.7A Clean the drill hole, if necessary		Loose ground is removed inside and around the hole.
7.8A Check the drill hole's depth	7.8A.1 Check the elevations	

TASK 7A: DRILL WITH A PNEUMATIC OR HYDRAULIC DRILL

Operations	Sub-Operations	Clarifications
7.9A "Break" the drill rods	7.9A.1 Remove the pressure put on the drill rod 7.9A.2 Place the rotation mechanism in the neutral position 7.9A.3 Make the hammer "dance," i.e., make it knock until the hammer vibrates in the coupling sleeve 7.9A.4 Constantly monitor drilling progress, particularly on fissured ground 7.9A.5 Stop the hammer 7.9A.6 Close the dust collector or cut the water supply 7.9A.7 Reverse the rotation direction and raise the hammer back up 7.9A.8 Keep the coupling sleeve on the drill rod	The purpose of the operation to "break" the drill rods is to unjam them.
7.10A Raise the hammer and grease the threads		It must regularly be ensured that the hammer receives sufficient oil to prevent it from heating. Special attention should be paid when greasing the hammer and threads of the impact rod and the steels. The threads' condition should also be checked during the drilling.
7.11A Install the upper coupling sleeve on the hammer, if applicable		
7.12A Install the other drill rod(s)	7.12A.1 Align the drill rod on the upper coupling sleeve and grease the threads 7.12A.2 Lower the hammer while rotating it slowly in the direction of drilling 7.12A.3 Check the rotation until the threads are well tightened	

TASK 7A: DRILL WITH A PNEUMATIC OR HYDRAULIC DRILL

Operations	Sub-Operations	Clarifications
7.13A Open the centralizer		
7.14A Repeat operations 7.1 to 7.7		
7.15A Proceed with the final flushing of the drill hole	7.15A.1 Activate the air pressure and the rotation to discharge residues 7.15A.2 Raise and lower the drill rods 7.15A.3 Add water, if applicable	
7.16A Stop the drilling operations		
7.17A Clean the drill hole's periphery		
7.18A "Break" the drill rods	See operation 7.9A.	
7.19A Remove the drill rods	7.19A.1 Raise the hammer and drill rod up to the top of the mast 7.19A.2 Close the centralizer on the lower coupling sleeve 7.19A.3 Manually unscrew the drill rod 7.19A.4 Lower the hammer and slightly screw the coupling on the lower sleeve 7.19A.5 Repeat the operations, if necessary	
7.20A Move the mast and drill, according to the drilling pattern		

TASK 7A: DRILL WITH A PNEUMATIC OR HYDRAULIC DRILL

Operations	Sub-Operations	Clarifications
7.21A Measure and note the drill hole's depth		The measurement is taken using a surveyor's chain.
7.22A Place mining exploration drill plugs		
7.23A Mark and protect the drill hole		The hole is "marked" to be easily located in the event, for example, of a snowfall.
7.24A Regularly check the wear of the drill bit and drill rods		They will be replaced if necessary.
7.25A Complete the drilling report		

TASK 7B: DRILL WITH A "DOWN THE HOLE" DRILL

Operations	Sub-Operations	Clarifications
7.1B Lower the hammer and drill rod and start the rotation		
7.2B Actuate the air control lever and the hammer		
7.3B Adjust the rotation and supply pressure according to the characteristics of the stone to be drilled		
7.4B Check the mast's tilt angle regularly (particularly when drilling on sloping ground)		

TASK 7B: DRILL WITH A “DOWN THE HOLE” DRILL

Operations	Sub-Operations	Clarifications
7.5B Actuate the dust collector or the water supply mechanism and make adjustments		
7.6B Monitor that the dust and drill chips are being evacuated		
7.7B Clean the drill hole, if applicable		Loose ground has to be removed inside and around the hole. Cleaning is manual, with a shovel.
7.8B Check the depth of the drill hole	7.8B.1 Check the elevations	
7.9B Unscrew the drill rod	7.9B.1 Check the presence of hammer oil inside the drill rod	Unscrewing is done with a hydraulic system or a hand wrench.
7.10B Assemble the rotary and grease the threads		
7.11B Install the second drill rod		
7.12B Repeat operations 7.1B to 7.7B		
7.13B Proceed with the final flushing of the drill hole	7.13B.1 Activate the air pressure and the rotation to discharge residues 7.13B.2 Raise and lower the drill rods 7.13B.3 Add water, if applicable	

TASK 7B: DRILL WITH A “DOWN THE HOLE” DRILL

Operations	Sub-Operations	Clarifications
7.14B Ensure that the hole's depth corresponds to the drilling plan		
7.15B Unscrew the second drill rod		
7.16B Remove the drill rods		
7.17B Measure and note the drill hole's depth		
7.18B Mark and protect the drill hole		
7.19B Move the drill according to the drilling pattern		
7.20B Regularly check the wear of the drill bit and drill rods		
7.21B Clean the drill hole's periphery		
7.22B Place mining exploration drill plugs for the next drilling		
7.23B Complete the drilling report		

TASK 7C: DRILL WITH A HAND-HELD AIR DRILL

Operations	Sub-Operations	Clarifications
7.1C Install the air line		
7.2C Install a lubricator on the air line and make sure it is effective	7.2C.1 Install a safety whip 7.2C.2 Fill the lubricator with oil 7.2C.3 Open the air inlet and check the oil outlet	
7.3C Choose drill rods		
7.4C Make sure the drill bits have a similar diameter	7.4C.1 Choose the diameter according to the drilling pattern 7.4C.2 Check the diameter with measuring tape	
7.5C Clean the drill hole's periphery		Cleaning is done with an air blast; the largest pieces are removed by hand.
7.6C Insert the drill rods in the air hammer or jackhammer	7.6C.1 Open the drill rod locking mechanism 7.6C.2 Insert the drill rods in it	
7.7C Actuate the drill and clean the hole regularly		Loose ground has to be removed inside and around the hole. Cleaning is manual, with a shovel.
7.8C Keep the drill at the required tilt angle		The hole's verticality or angle should be checked regularly.
7.9C Replace the drill rod regularly and store it		The drill rod should be replaced according to the required depth. It is important not to leave the drill rods on the ground.

TASK 7C: DRILL WITH A HAND-HELD AIR DRILL

Operations	Sub-Operations	Clarifications
7.10C Check the depth of the drill hole	7.10C.1 Check the elevations	
7.11C Place mining exploration drill plugs		The mining exploration drill plugs are placed to plug and protect the drilled holes.

TASK 8: REPLACE BROKEN OR STUCK DRILL RODS

Operations	Sub-Operations	Clarifications
8.1 Unscrew the drill rods	(See 7.9B)	
8.2 Remove the drill rods down to the break		
8.3 Replace the upper part of broken drill rods and add extractors to them		The extractors may be concave or convex.
8.4 Press the extractor on the lower part of broken drill rods		
8.5 Apply slight pressure on the rotary		The extractor must be struck to get a good grip on the drill rod.
8.6 Actuate the air supply mechanism to extract dust		
8.7 Stop the air, if applicable		

TASK 8: REPLACE BROKEN OR STUCK DRILL RODS

Operations	Sub-Operations	Clarifications
8.8 Raise and unscrew the lower part of drill rods up to the extractor		Once the extractor is above, press on the centralizer.
8.9 Remove the lower part of broken drill rods		Once the drill rod is extracted, the extractor has to be unscrewed and removed.
8.10 Recover the hammer, if applicable		This operation applies to “down the hole” drills.
8.11 Replace the lower part of broken drill rods		

TASK 9: DRILL WITH A WINCH

Operations	Sub-Operations	Clarifications
9.1 Check the condition of the cable and its attachments	9.1.1 Unroll the cable fully 9.1.2 Detect anomalies 9.1.3 Roll up the cable 9.1.4 Check the fastening of the winch	
9.2 Locate and drill tilting anchor points		The anchor points have to be drilled in original rock. The driller is the one who, with a visual inspection, determines whether the rock is original.
9.3 Install anchors solidly in the rock and position the drill		
9.4 Hang the winch cable to the anchor bolt		

TASK 9: DRILL WITH A WINCH

Operations	Sub-Operations	Clarifications
9.5 Ensure the strength of cables and attachments	9.5.1 Actuate the winch to provoke tension 9.5.2 Check the cable under tension and the accessories	For example, if the cable comes in contact with the rock and friction is produced, it is necessary to place a wooden block under the cable to prevent the cable from wearing out and eventually breaking.
9.6 Install pulleys, if applicable		
9.7 Lower the drill perpendicularly to the slope	9.7.1 Guide the drill's descent by modifying the winch cable tension as necessary 9.7.2 Position the mast so as to stabilize the drill 9.7.3 Keep the drill perpendicular to the slope and avoid lateral movements	
9.8 Stabilize the drill's drive mechanism		
9.9 Install an independent anchor to enable the driller to fasten his lifeline		
9.10 Drill		
9.11 Check the depth of the drilled hole		
9.12 Place mining exploration drill plugs		

TASK 9: DRILL WITH A WINCH

Operations	Sub-Operations	Clarifications
9.13 Use the winch to raise the drill to the top of the slope	9.13.1 Make sure to maintain cable tension 9.13.2 Make sure the cable rolls up correctly 9.13.3 Position the mast 9.13.4 Raise the drill back up to the anchor point	
9.14 Remove all anchors after the drill has been raised		
9.15 Stabilize the drill before shut off		

TASK 10: ORGANIZE THE BLASTING

Operations	Sub-Operations	Clarifications
10.1 Receive instructions from one's supervisor		The instructions may pertain to the following aspects: number of holes, depth of holes, blast time, blast location, etc.
10.2 Locate and inspect the work area		The presence of water, stray currents, access roads, residences, electric lines, gas lines, etc. have to be checked
10.3 Find out about regulations specific to the work area, if applicable		The regulations may be municipal (e.g.: start and completion of work), environmental or specific to the main contractor.
10.4 Obtain the various necessary permits		The participants pointed out that this operation is not always performed by the blaster-driller. Often the foreman or contractor seeks the various permits. However, the blaster-driller must make sure to have them and check their compliance. The permits pertain to: magazines, the transportation of explosives, the immediate loading of explosives, etc.

TASK 10: ORGANIZE THE BLASTING

Operations	Sub-Operations	Clarifications
10.5 Determine the location of magazines and install them		
10.6 Display the permits		The permits must be clearly displayed.
10.7 Choose the types of explosives and the blasting accessories and place the order		The choice of explosives will be made according to the type of rock, the nature of the soil (e.g.: presence of water), the volume of rock to be dynamited, the work area (e.g.: controlling noise and vibrations near residences), the cost of explosives, etc. The explosives may be in sticks, bagged or in bulk.
10.8 Check the explosives and accessories received and store them in their respective magazines		The verification must pertain to compliance with the order, the explosives' expiry date, their condition, etc.
10.9 Complete the inventory log		The explosives' inventory log must be kept up-to-date at all times. It contains the quantities of each type of explosive, the explosives used and the remaining ones, etc.
10.10 Install jobsite boxes		Determine a safe location, in the blaster's line of sight. The boxes must be locked at all times.
10.11 Install safety signs		The signs must be displayed at the construction site's entrance and must explain the blasting procedure.
10.12 Ensure the availability of measuring and verification instruments		Instruments such as gas detectors, lightning detectors, seismograph, etc.

TASK 11: INSPECT AND MAINTAIN THE BLASTING EQUIPMENT AND ACCESSORIES

Operations	Sub-Operations	Clarifications
11.1 Make sure to have the necessary equipment and accessories		They are, for example, tamping rods, shovels, pails, etc.
11.2 Check firing accessories		Accessories such as a lead wire, batteries, galvanometers, exploders, etc.
11.3 Check the siren's operation		
11.4 Check the placards		
11.5 Make necessary corrections, if applicable		

TASK 12A: LOAD THE DRILL HOLES (ELECTRIC INITIATION)

Operations	Sub-Operations	Clarifications
12.1A Inspect all drill holes	12.1A.1 Consult the drilling report 12.1A.2 Check the holes' condition	
12.2A Identify the loading area		A safety perimeter must be established around the loading area.
12.3A Transport the explosives	12.3A.1 Inspect the truck 12.3A.2 Make sure of the truck's capacity 12.3A.3 Ensure that permits are obtained for the truck and the driver 12.3A.4 Load the explosives and accessories in the truck 12.3A.5 Complete the waybill and the magazine's inventory log 12.3A.6 Place signs on the truck 12.3A.7 Go to the blast area	

TASK 12A: LOAD THE DRILL HOLES (ELECTRIC INITIATION)

Operations	Sub-Operations	Clarifications
12.4A Place the explosives and accessories in the jobsite boxes		
12.5A Develop the firing plan		The firing plan will be developed according to the desired blast direction, the rock characteristics, the constraints of the ground, etc.
12.6A Determine the loading sequence		Generally, loading starts from the rock face.
12.7A Distribute detonators according to the firing plan		
12.8A Assemble the primer cartridge and insert it in the drill hole		
12.9A Fill the hole with explosives up to the planned height		
12.10A Check load continuity in the hole		
12.11A Plug the hole with the mining exploration drill plug, if applicable		
12.12A Complete the firing log		The log is completed while the task is being performed.
12.13A Connect leg wires according to the firing plan		

TASK 12A: LOAD THE DRILL HOLES (ELECTRIC INITIATION)

Operations	Sub-Operations	Clarifications
12.14A Balance the series of circuits according to the exploder's capacity		
12.15A Check circuit continuity and calculate resistance ¹⁶		
12.16A Remove the mining exploration drill plug and tamp the drill holes		The drill holes may be filled with crushed stone (0-¾ net)
12.17A Use a galvanometer to recheck the circuit		
12.18A Isolate each exposed electrical connection		
12.19A If applicable, check each series of circuits and the entire firing plan		If a circuit is comprised of non-electric detonators and is initiated by an electric detonator, this verification is not necessary. However, it is essential if a circuit is comprised of electric detonators and is initiated by a detonator that is also electric.
12.20A Ensure the safety of the blast area by assigning someone to monitor (in the blaster's absence)		The person assigned – often the assistant blaster – must hold a general explosives permit issued by the Sûreté du Québec.

16. According to the Safety Code for the construction industry (Division 4, section 4.6.9.1), when loading a blasthole, a protective buffer 100 mm thick must be inserted between the explosive load and the regular tamping. Otherwise, untamping the blasthole is strictly prohibited in all circumstances.

TASK 12B: LOAD THE DRILL HOLES (NON-ELECTRIC INITIATION, WITH OR WITHOUT A DETONATING CORD)

Operations	Sub-Operations	Clarifications
12.1B to 12.12B Perform operations 12.1A to 12.12A		
12.13B Tamp the drill holes		
12.14B Extend the detonating cord and connect the shock tubes		This involves extending the detonating cord and then either connecting the shock tubes of each drill hole or connecting the shock tubes to one another.
12.15B Distribute and connect surface timers according to the firing plan		
12.16B Check the entire circuit		
12.17B Protect the surface connections, if applicable		The surface connections are protected with sand or drilling dust.
12.18B Ensure the safety of the blast area by assigning someone to monitor (in the blaster's absence)		The person assigned – often the assistant blaster – must hold a general explosives permit issued by the Sûreté du Québec.
12.19B Temporarily store surplus explosives in the jobsite boxes		
12.20B Put blasting mats in place, if applicable		It is important to make sure not to damage connections when putting mats in place. The mats are installed to protect buildings or infrastructures against hazards from rock projections and to attenuate noise.

TASK 12B: LOAD THE DRILL HOLES (NON-ELECTRIC INITIATION, WITH OR WITHOUT A DETONATING CORD)

Operations	Sub-Operations	Clarifications
12.21B Install the seismograph at the designated location, if applicable		
12.22B Store unused explosive products in their respective magazines		

TASK 12C: LOAD THE DRILL HOLES (ELECTRONIC INITIATION)

Operations	Sub-Operations	Clarifications
12.1C to 12.12C Perform operations 12.1A to 12.12A		
12.13C Tamp the drill holes		Drill holes may be filled with crushed stone (0-¾ net).
12.14C Identify the timers for each hole		This operation is performed with a scanner.
12.15C Connect the electronic detonator to the main lead wire		
12.16C Check the entire circuit		It must be ensured that all holes are connected and that connections are well made.
12.17C Protect surface connections by using the appropriate material, if applicable		The connections are protected by a membrane or sand.

TASK 12C: LOAD THE DRILL HOLES (ELECTRONIC INITIATION)

Operations	Sub-Operations	Clarifications
12.18C Ensure the safety of the blast area by assigning someone to monitor (in the blaster's absence)		The person assigned – often the assistant blaster – must hold a general explosives permit issued by the Sûreté du Québec.
12.19C Temporarily store surplus explosives		The explosives must be stored in jobsite boxes or a vehicle approved for that purpose.
12.20C Put blasting mats in place, if applicable		
12.21C Install the seismograph at the designated location, if applicable		
12.22C Store unused explosive products in their respective magazines		

TASK 13: EXTEND THE LEAD WIRE

Operations	Sub-Operations	Clarifications
13.1 Delimit the safety perimeter and ensure that it is deserted		The blaster-driller must ensure that no vehicle or equipment will damage the lead wire.
13.2 Determine the firing point and fully unroll the lead wire		The firing point is generally positioned behind the blast and always at a safe distance from the blaster-driller.
13.3 Test the lead wire (open and closed)		A galvanometer is used to perform this test.

TASK 13: EXTEND THE LEAD WIRE

Operations	Sub-Operations	Clarifications
13.4 Short-circuit the lead wire at the firing point		The wires must cross over each other to prevent undesired or unforeseen explosions.
13.5 Return to the blast area and check the entire circuit		It must be ensured that everything is connected, that the wires are in good condition, that the firing sequence is appropriate, that unused explosives have been stored in a safe place, etc.

TASK 14: FIRE THE EXPLOSIVES

Operations	Sub-Operations	Clarifications
14.1 Ensure that the blast area is fully evacuated		The verification is made by radio. All persons, as well as equipment and vehicles, must be moved to beyond the safety perimeter.
14.2 Connect the lead wire to the blast circuit	14.2.1 Connect the electric lead wire to the lead wire of each series of detonators 14.2.2 Connect the non-electric lead wire to the main detonator (to prevent stray currents) and afterward, when the blast is imminent, connect that detonator to the circuit	
14.3 Check the exploder's load		It is always preferable to have a spare exploder, in case of a defect.
14.4 Use the appropriate signals prior to firing		The blaster signals the firing with a siren, whose use is prescribed by the Safety Code for the construction industry.
14.5 Connect the lead wire to the exploder		
14.6 Proceed with firing		

TASK 14: FIRE THE EXPLOSIVES

Operations	Sub-Operations	Clarifications
14.7 Disconnect and short-circuit the exploder's lead wire		
14.8 Observe the regulatory period before returning to the blast area		This period, imposed by section 4.8.2 of the du Safety Code for the construction industry, is to allow the evacuation of gases in order to prevent poisoning.
14.9 Store the exploder in a secure location		

TASK 15: INSPECT THE BLAST AREA

Operations	Sub-Operations	Clarifications
15.1 Assess the blast results		This is to check that the expected results have been met: stone size, blast direction, projections, etc.
15.2 Find misfires, if applicable		Misfires (explosives that have not exploded as expected or have not exploded at all) are detected by a visual inspection of all holes. When finding misfires, the blaster-driller may try a secondary initiation to make those explosives explode, if they have not deteriorated. He may also put them at the location of a subsequent blast to destroy them. In all cases, safety measures and manufacturer recommendations for those explosives must be taken into account.
15.3 Authorize traffic within the blast area	15.3.1 Check the traffic lanes 15.3.2 Detect rocks that might hinder traffic 15.3.3 Clean the accesses or have them cleaned 15.3.4 Authorize traffic after the sound signal	

TASK 15: INSPECT THE BLAST AREA

Operations	Sub-Operations	Clarifications
15.4 Roll up the lead wire		
15.5 Empty the jobsite boxes		An inventory of remaining explosives must be made while the jobsite boxes are being emptied.
15.6 Recover the seismograph		Check the seismograph results – for example, vibrations and noise caused by the blast, the blast time and date, etc.
15.7 Conclude the firing log		The firing log must include all the information about the blast executed – for example, quantities and type of explosives used, accessories used, number of holes, blast time, blast plan, blast results, etc.
15.8 Complete the waybill		The waybill must account for the explosives and detonators to be transported, the destination, date, etc.
15.9 Store surplus explosives in the magazine		
15.10 Make an inventory of the explosives and complete the inventory log		The explosives inventory must be kept up-to-date throughout blasting operations. The storage area must be up to standards, and doors must be locked at all times.
15.11 Eliminate deteriorated explosives and the empty containers		The elimination complies with the methods recommended by explosives manufacturers. Empty explosives containers are returned to manufacturers or destroyed (burned).

2.3 ACHIEVEMENT CONDITIONS

Data on achievement conditions were collected for the blaster-driller 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 areas¹⁷ Blaster-drillers work on construction sites for the production of various works, mainly roads, dams, sewers, aqueducts, tunnels, foundations, etc. They work almost exclusively outdoors and are thus exposed to climate variations and rigours. They also occasionally work underground (tunnels). Their work environment includes loud noises and dust. They have to move on rough and often steep and muddy terrain.
Collaboration and supervision Blaster-drillers generally work without direct supervision. They have contacts with their blaster-driller colleagues, assistant blasters and labourers, their immediate supervisor, the foreman, superintendents and supervisors, surveyors, engineers, etc.
Instructions During drilling, verbal instructions generally come from the foreman (ground constraints, equipment to be used, etc.), but also from the blaster responsible for the blasting, from the surveyor or from the engineer. Written instructions appear on the drilling pattern and survey plans. At the time of blasting, verbal instructions generally come from the foreman (hours, projections, etc.), but also, occasionally, from the surveyor or geologist. Written instructions are given in the firing plan.

17. Non-exhaustive list.

ACHIEVEMENT CONDITIONS

Stress factors

Blaster-drillers have to cope with following main stress factors:

- equipment failures and unavailable spare parts or accessories, thus causing delays;
- noise, dust, climate (bad weather, heat, cold, etc.);
- rough ground, which requires good mastery of the drill;
- fall hazards on steep ground;
- hazards of equipment failure and cable breaks;
- injury hazards from moving and rotating parts;
- the proximity of residences, underground lines or electric lines;
- the geological features of often difficult terrain;
- meeting the blast schedule.

In addition, fatigue due to long working hours may also make the blaster-driller more sensitive to the various stress factors. Finally, the participants mentioned that the level of stress from drilling tasks is less than from blasting tasks. This difference is reportedly because blast hazards are greater. The main stress factors from drilling is said to be related to difficult ground conditions.

References

Blaster-drillers refer mainly to:

- plans and specifications;
- the equipment manufacturer's manual;
- the drill operator's manual;
- the reference manual for calculating drill angles;
- load tables;
- drilling and firing plans;
- the technical sheets of explosives manufacturers.

Raw materials, tools and equipment

Annex 1 of the present report contains a list of material resources used by blaster-drillers in the practice of their occupation.

ACHIEVEMENT CONDITIONS

Health and safety hazards

According to the participants, the main health and safety hazards to which blaster-drillers are exposed are the following:

- various falls and injuries during movements on rough ground;
- various injuries while drills and other machines are moved;
- various injuries due to rotating parts, heavy mobile parts, projections, unforeseen blasts, installing and removing mats, pressurized air jets, chips of broken metal parts, the explosion of compressed air pipes, winch cable breaks, poor handling of explosives, etc.;
- electrocution during work near electric lines;
- twisting, wrist injuries, backaches or falls caused by the use of a hand drill;
- intoxication due to gas emissions;
- respiratory disorders due to dust inhalation;
- hearing problems due to noise.

In addition, the participants mentioned that any factor hindering the concentration of blaster-drillers, particularly during blasting tasks, could have serious effects on the health and safety of workers and anyone near a blast.

Moreover, Annex 2 of the present report contains a more detailed list of the hazards related to the tasks and operations of the blaster-driller occupation, 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. Their results were then collected and presented in full session. Thus, certain criteria may at times be as relevant for tasks other than those for which they have been retained herein.

Table 2.4 Performance Criteria

TASK 1	PREPARE THE DRILLING
Performance Criteria	
– Observance of occupational health and safety rules – Correct interpretation of instructions – Efficient planning of the work – Sound choice of materials and equipment – Anticipating spare accessories in case of failures – Clean and functional materials and equipment – Sufficient quantity of fuel – Correctly loading the drill on the float – Communicating effectively with other workers and with supervisors – Clear and complete report	
TASK 2	ORGANIZE THE DRILLING
Performance Criteria	
– Observance of occupational health and safety rules – Compliant application of received instructions – Communicating effectively with other workers and with supervisors – Efficient planning of the work – Passable and safe accesses – Sound and full assessment of ground constraints – Observance of laws and regulations in effect – Efficient organization of the work area – Appropriate use of tools and equipment	
TASK 3	INSPECT AND MAINTAIN DRILLING EQUIPMENT AND ACCESSORIES
Performance Criteria	
– Observance of occupational health and safety rules – Correct interpretation of instructions – Efficient planning of the work – Regular maintenance of equipment and accessories – Clean and functional materials, equipment and accessories – Sound hose and safety whip connections – Sufficient quantity of fuel – Carefully checking the operation of equipment and accessories – Meticulous detection of any anomaly – Appropriate corrections of anomalies, if applicable – Accurately reporting anomalies detected and corrections made – Effectively planning fluid supplies	

TASK 4	DEVELOP THE DRILLING PATTERN
Performance Criteria	
– Observance of occupational health and safety rules – Correct interpretation of instructions – Sound analysis of ground constraints – Observance of laws and regulations in effect – Appropriately examining rock characteristics – Collecting all important data – Clear and precise drilling pattern – Doing the work precisely and autonomously	
TASK 5	MARK THE DRILLING POINTS
Performance Criteria	
– Observance of occupational health and safety rules – Observance of the established drilling pattern – Correct use of the measurement template, if applicable – Exact measurements and data – Precisely marking the parameters – Correct layout of mining exploration drill plugs – Doing the work precisely and autonomously	
TASK 6	PREPARE THE DRILL FOR THE WORK
Performance Criteria	
– Observance of occupational health and safety rules – Appropriately positioning the drill – Correct direction of the mast in relation to the ground – Solid connections – Observance of the required drilling angle – Taking ground constraints into account	
TASK 7A	DRILL WITH A PNEUMATIC OR HYDRAULIC DRILL
TASK 7B	DRILL WITH A “DOWN THE HOLE” DRILL
TASK 7C	DRILL WITH A HAND-HELD AIR DRILL
Performance Criteria	
– Observance of occupational health and safety rules – Observance of laws and regulations in effect – Observance of work techniques – Efficient planning of the work – Observance of the drilling plan – Appropriate diameter and depth of the holes drilled – Holes free of loose ground – Moving the drill according to predetermined accesses – Communicating effectively with other workers and with supervisors – Appropriate use of tools and equipment – Doing the work precisely and autonomously	

TASK 8	REPLACE BROKEN OR STUCK DRILL RODS
Performance Criteria	
– Observance of occupational health and safety rules – Observance of laws and regulations in effect – Observance of work techniques – Diligence in recovering broken or jammed components – Handling broken or jammed components carefully – Communicating effectively with other workers and with supervisors – Appropriate use of tools and equipment – Doing the work precisely and autonomously	
TASK 9	DRILL WITH A WINCH
Performance Criteria	
– Observance of occupational health and safety rules – Observance of laws and regulations in effect – Observance of work techniques – Taking the ground's slope into account – Observance of winch capacities – Soundly assessing the progress of the work – Effectively adapting to ground peculiarities – Communicating effectively with other workers and with supervisors – Appropriate use of tools and equipment – Doing the work precisely and autonomously	
TASK 10	ORGANIZE THE BLASTING
Performance Criteria	
– Observance of occupational health and safety rules – Observance of laws and regulations in effect – Compliant application of received instructions – Communicating effectively with other workers and with supervisors – Efficient planning of the work – Compliant installation of magazines and jobsite boxes – Sound and full assessment of ground constraints – Carefully checking and appropriately displaying permits – Sound choice of explosives and accessories – Compliant storage of explosives – Appropriate use of tools and equipment – Diligently updating the inventory log – Carefully checking the availability of measuring instruments	

TASK 11	INSPECT AND MAINTAIN THE BLASTING EQUIPMENT AND ACCESSORIES
Performance Criteria	
– Observance of occupational health and safety rules – Correct interpretation of instructions – Efficient planning of the work – Regular maintenance of equipment and accessories – Carefully checking the operation of equipment and accessories – Carefully cleaning and storing equipment and accessories – Meticulous detection of any anomaly – Appropriate corrections of anomalies, if applicable – Accurately reporting anomalies detected and corrections made – Doing the work precisely and autonomously	
TASK 12A	LOAD THE DRILL HOLES (ELECTRIC INITIATION)
TASK 12B	LOAD THE DRILL HOLES (NON-ELECTRIC INITIATION, WITH OR WITHOUT A DETONATING CORD)
TASK 12C	LOAD THE DRILL HOLES (ELECTRONIC INITIATION)
Performance Criteria	
– Observance of occupational health and safety rules – Observance of laws and regulations in effect – Compliant application of received instructions – Carefully handling explosives – Clear and complete firing plan – Observance of loading steps – Following the recommendations of explosives manufacturers – Doing the work precisely and autonomously – Diligently updating the inventory log – Correct positioning of mining exploration drill plugs, if applicable – Carefully checking circuit continuity – Compliant storage of surplus explosives	
TASK 13	EXTEND THE LEAD WIRE
Performance Criteria	
– Observance of occupational health and safety rules – Observance of laws and regulations in effect – Compliant application of received instructions – Appropriate and deserted safety perimeter – Sound determination of the firing point – Carefully checking the entire circuit – Observance of the steps – Doing the work precisely and autonomously	

TASK 14	FIRE THE EXPLOSIVES
Performance Criteria	
– Observance of occupational health and safety rules – Observance of laws and regulations in effect – Compliant application of received instructions – Communicating effectively with other workers and with supervisors – Carefully checking the safety perimeter and its evacuation – Observance of the blasting steps – Carefully handling the exploder – Using appropriate signals – Meeting deadlines – Clear and precise radio communications – Doing the work precisely and autonomously	
TASK 15	INSPECT THE BLAST AREA
Performance Criteria	
– Observance of occupational health and safety rules – Observance of laws and regulations in effect – Sound assessment of blast results – Careful detection of explosives that have not exploded – Doing the work precisely and autonomously – Carefully handling explosives and accessories – Compliant storage of explosives – Complete and precise firing log – Diligently updating the inventory log	

2.5 FUNCTIONS

Functions correspond to a set of interrelated tasks. That set may be defined by the work results or by a sequence of tasks.

For the blaster-driller occupations, two functions appear to stand out:

- a function related to **drilling**, and grouping the following tasks:
 - Prepare the drilling;
 - Organize the drilling;
 - Inspect and maintain drilling equipment and accessories;
 - Develop the drilling pattern;
 - Mark the drilling points;

- Prepare the drill for operation;
 - Drill with a pneumatic or hydraulic drill;
 - Drill with a “down the hole” drill;
 - Drill with a hand-held air drill;
 - Replace broken or stuck drill rods;
 - Drill with a winch;
- a function related to **blasting**, and grouping the following tasks:
 - Organize the blasting;
 - Inspect and maintain the blasting equipment and accessories;
 - Load the drill holes (electric initiation);
 - Load the drill holes (non-electric initiation, with or without a detonating cord);
 - Load the drill holes (electronic initiation);
 - Extend the lead wire;
 - Fire the explosives;
 - Inspect the blast area.

3. QUANTITATIVE DATA ON TASKS

3.1 OCCURRENCE

Occurrence data concern the percentage of blaster-drillers who perform a task in the same work environment. The data presented in the tables below are the average results of the blaster-drillers attending the workshop. However, they account for the work time not only of the participants, but also of all blaster-drillers working in the companies represented.

Table 3.1 Task Occurrence

Tasks		Occurrence
1	Prepare the drilling	53.8%
2	Organize the drilling	43.17%
3	Inspect and maintain drilling equipment and accessories	63.0%
4	Develop the drilling pattern	30.6%
5	Mark the drilling points	42.33%
6	Prepare the drill for the work	57.0%
7A	Drill with a pneumatic or hydraulic drill	58.8%
7B	Drill with a “down the hole” drill	34.0%
7C	Drill with a hand-held air drill	35.0%
8	Replace broken or stuck drill rods	49.7%
9	Drill with a winch	45.5%
10	Organize the blasting	48.0%
11	Inspect and maintain the blasting equipment and accessories	52.6%
12A	Load the drill holes (electric initiation)	28.6%
12B	Load the drill holes (non-electric initiation, with or without a detonating cord)	53.2%
12C	Load the drill holes (electronic initiation)	21.6%
13	Extend the lead wire	62.8%
14	Fire the explosives	40.9%
15	Inspect the blast area	46.8%

3.2 WORK TIME

Work time, also expressed in percentages, represents, on average, the time allocated to each task by the participants, on an **annual** basis.

Table 3.2 Work Time Allocated to Each Task

Tasks	Work Time
1 Prepare the drilling	4.9%
2 Organize the drilling	2.9%
3 Inspect and maintain drilling equipment and accessories	3.8%
4 Develop the drilling pattern	3.2%
5 Mark the drilling points	4.6%
6 Prepare the drill for the work	5.3%
7A Drill with a pneumatic or hydraulic drill	16.8%
7B Drill with a “down the hole” drill	4.6%
7C Drill with a hand-held air drill	1.8%
8 Replace broken or stuck drill rods	4.2%
9 Drill with a winch	4.8%
10 Organize the blasting	6.1%
11 Inspect and maintain the blasting equipment and accessories	3.6%
12A Load the drill holes (electric initiation)	2.7%
12B Load the drill holes (non-electric initiation, with or without a detonating cord)	16.6%
12C Load the drill holes (electronic initiation)	2.0%
13 Extend the lead wire	3.5%
14 Fire the explosives	4.8%
15 Inspect the blast area	3.8%
	100%

Upon examination of the work time allocation, we note that tasks 7A, “Drill with a pneumatic or hydraulic drill” (16.8%), and 12B, “Load the drill holes (non-electric initiation, with or without a detonating cord)” (16.6%), take up more of the work time, i.e., in total, around one third of the latter (33.4%). The time taken for each of the other tasks varies between 1.8% (task 7C, “Drill with a hand-held air drill”) and 6.1% (task 10, “Organize the blasting”). We also note that drilling tasks (1 to 9) take up slightly over half (56.5%) of the work time, whereas blasting tasks take up 43.1%.

Of the 12 workshop participants, the great majority perform drilling and blasting tasks. Only one participant exclusively performs drilling tasks, whereas another one exclusively performs blasting tasks. However, not all the tasks are performed by all the participants. The table below presents the number of workshop participants (out of 12) who perform each of the tasks.

Table 3.3 Number of Persons Who Perform Each Task

Tasks		Number of Persons Who Perform the Task
1	Prepare the drilling	11
2	Organize the drilling	11
3	Inspect and maintain drilling equipment and accessories	9
4	Develop the drilling pattern	10
5	Mark the drilling points	11
6	Prepare the drill for the work	9
7A	Drill with a pneumatic or hydraulic drill	9
7B	Drill with a “down the hole” drill	6
7C	Drill with a hand-held air drill	4
8	Replace broken or stuck drill rods	9
9	Drill with a winch	8
10	Organize the blasting	10
11	Inspect and maintain the blasting equipment and accessories	11
12A	Load the drill holes (electric initiation)	5
12B	Load the drill holes (non-electric initiation, with or without a detonating cord)	9
12C	Load the drill holes (electronic initiation)	6
13	Extend the lead wire	9
14	Fire the explosives	10
15	Inspect the blast area	11

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 outcome, the costs, health and safety, etc.
2. Not very important: Poor execution of the task could lead to an outcome of lesser quality, to minimal costs, minor injury or accident hazards, etc.
3. Important: Poor execution of the task could lead to an unsatisfactory outcome, substantial additional costs, injuries, accidents, etc.
4. Very important: Poor execution of the task could lead to an unacceptable outcome and very serious 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.

The data presented in the table below are the average results for the workshop participants.

Table 3.4 Importance and Difficulty of Tasks

Tasks		Importance	Difficulty
1	Prepare the drilling	3.7	1.9
2	Organize the drilling	3.4	2.1
3	Inspect and maintain drilling equipment and accessories	2.9	1.6
4	Develop the drilling pattern	3.6	2.3
5	Mark the drilling points	3.3	1.6
6	Prepare the drill for the work	3.2	1.5
7A	Drill with a pneumatic or hydraulic drill	3.0	2.2
7B	Drill with a “down the hole” drill	3.2	2.5
7C	Drill with a hand-held air drill	3.0	2.5
8	Replace broken or stuck drill rods	2.5	3.1
9	Drill with a winch	3.8	3.1
10	Organize the blasting	3.6	2.4
11	Inspect and maintain the blasting equipment and accessories	3.3	1.9
12A	Load the drill holes (electric initiation)	3.3	2.7
12B	Load the drill holes (non-electric initiation, with or without a detonating cord)	3.6	2.4
12C	Load the drill holes (electronic initiation)	3.7	2.9
13	Extend the lead wire	3.1	1.3
14	Fire the explosives	3.8	1.3
15	Inspect the blast area	4.0	1.6

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 blaster-driller occupation.

4.1 KNOWLEDGE

Communication

In the course of their work, blaster-drillers have to communicate with various persons. So they must be able to maintain good relations and provide clear and accurate information. Moreover, before and after blasting, they have to communicate by radio, which requires a mastery of the signals and codes specific to this means of transmitting information, in the context of blasting.

Electronics and computers

Given that some equipment is equipped with electronic controls, blaster-drillers using it must be able to enter simple data. This type of controls is not yet present on all machines, but it is becoming more and more prevalent.

In addition, blaster-drillers' use of drilling simulators, and the design of computerized firing plans, are seen ever more frequently. The application of basic computer concepts will grow in importance in coming years.

Drilling and blasting

The blaster-driller must know the various types of drills, their components and accessories, as well as their features and performances. He must also know the various explosives, their properties, applications, handling method, cost, etc., as well as the types of detonators, their properties and applications.

Finally, the blaster-driller must know the standards, laws and regulations governing his work, particularly federal and provincial laws with regard to explosives, the Safety Code for the construction industry, municipal by-laws, and regulations specific to client companies. In addition, they must know the safety measures for each of their tasks, equipment or explosive product used, and they must be able to set a safety perimeter in compliance with the regulations in effect.

Measuring and detection instruments

The blaster-driller must have a good knowledge of the operating method and the use of the various measuring and detection instruments he needs for his work, such as: seismograph, galvanometer, storm / lightning detector, gas detectors (e.g.: carbon dioxide), etc.

Mathematics

Blaster-drillers have to do various calculations to perform their duties. For example, they must use the rule of three to convert metric to imperial units (and vice-versa). They must perform basic arithmetic operations to calculate load rates, establish the drilling plan, calculate necessary periods, assess the necessary quantities of explosives, keep the explosives inventory log up-to-date, etc.

They must also apply concepts of geometry, for example to determine an angle, calculate a hypotenuse or apply the Pythagorean theorem, and they must apply concepts of trigonometry to calculate sines and cosines.

Mechanics

On smaller construction sites, basic mechanical concepts are useful to the blaster-driller so that he can detect equipment problems and make minor corrections. On larger construction sites, a mechanic is assigned to make repairs.

Plans and specifications

Given that the blaster-driller may have to interpret plans and specifications, he must know the various symbols, scales, abbreviations, etc.

Sciences

The blaster-driller must know basic concepts of geology to determine the types of soil and rock, in order to anticipate their reactions to drilling and blasting. He must also have a basic knowledge of certain principles of physics, such as pressure, rotation, percussion, friction, etc.

4.2 SKILLS

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

Cognitive skills

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

- logic (e.g.: to solve problems, adapt to a variety of situations, plan the work and set priorities);
- judgment (e.g.: to evaluate situations, assess risks, find alternative solutions);
- decision-making (e.g.: to face contingencies).

Motor skills

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

- good physical condition and endurance;
- good reflexes.

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 blaster-drillers need are the following:

- good vision, to locate slopes and assess the terrain;
- good hearing, to detect an abnormal noise, a gas or fluid leak;
- good sense of smell, to detect overheating or a gas leak.

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 blaster-drillers need are the following:

- calm and patience, to face contingencies and adapt to a variety of situations;
- leadership, team spirit, ability to compromise;
- rigour and vigilance, to observe procedures, laws and regulations, and to ensure work quality and worker safety;
- quick reactions, to face contingencies.

5. TRAINING SUGGESTIONS

Initial training

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

- alternate between the more theoretical courses and practical activities, since this method has yielded good results where it has been applied;
- training centres should have more equipment or admit less students;
- allow students to develop their skills in the field that interests them (drilling or blasting);
- allow students to have internships directly in the workplace, on construction sites;
- for blasting, require a certain number of working hours (as is the case for construction trades) and experience in the various sectors (quarries, construction, etc.) before being admitted to the blaster certification examination. There should also be an examination at the end of the 3,000 hours for class B.

Continuous training and professional development

For professional development, the participants suggest activities pertaining to:

- a general and continuous update on new explosives;
- new drilling equipment and accessories, cab drills, remote-controlled drills, drills with electronic boards, etc.;
- using the winch when drilling;
- underground work (tunnels);
- using the seismograph;
- using nacelles to work at heights;
- preparing for the position of foreman.

In addition, the participants suggest adjusting course schedules to the availability of the majority of blaster-drillers, particularly in winter. They also mention that training centres should use more-recent equipment (some centres currently use drill models no longer used on construction sites).

Annexes

Annex 1

Raw Materials, Tools and Equipment

During the workshop, the participants were presented lists of raw materials, tools and equipment. The following pages contain a list validated by the participants regarding raw materials, tools and equipment for each task.

Grey boxes indicate **unused** items.
Dashes indicate that the task was not discussed here.

Table A.1 Raw materials, Tools and Equipment

	Prepare the drilling	Organize the drilling	Inspect and maintain drilling equipment and accessories	Develop the drilling pattern	Mark the drilling points	Prepare the drill for the work	Drill with a pneumatic or hydraulic drill	Drill with a "down the hole" drill	Drill with a hand-held air drill	Replace broken or stuck drill rods	Drill with a winch	Organize the blasting	Inspect and maintain the blasting equipment and accessories	Load the drill holes (electric initiation)	Load the drill holes (non-electric initiation, with or without a detonating cord)	Load the drill holes (electronic initiation)	Extend the lead wire	Fire the explosives	Inspect the blast area
DEVICES, MACHINES AND HEAVY EQUIPMENT																			
Compliant truck for explosives													-						
Service truck													-						
Straight truck													-						
Compressor for hand drills													-						
Compressor on wheels for pneumatic drills													-						
Hydraulic drill on tracks													-						
Hand-held air drill													-						

	Prepare the drilling	Organize the drilling	Inspect and maintain drilling equipment and accessories	Develop the drilling pattern	Mark the drilling points	Prepare the drill for the work	Drill with a pneumatic or hydraulic drill	Drill with a "down the hole" drill	Drill with a hand-held air drill	Replace broken or stuck drill rods	Drill with a winch	Organize the blasting	Inspect and maintain the blasting equipment and accessories	Load the drill holes (electric initiation)	Load the drill holes (non-electric initiation, with or without a detonating cord)	Load the drill holes (electronic initiation)	Extend the lead wire	Fire the explosives	Inspect the blast area
Pneumatic drill on tracks													-						
Portable generator													-						
(gas) water pump													-						
Submersible pump with siphon and return													-						
Magazines													-						
Fuel tank													-						
Water tank													-						
TOOLS AND INSTRUMENTS																			
Grinding machine													-						
Detonation speed measuring device													-						
Acoustic warning devices (siren, whistler)													-						
Clinometer													-						
Detonator													-						
Exploder													-						
Grease gun													-						
Electric sequential machine													-						
Sledgehammer													-						
Hammer													-						
Multimeter													-						
Level													-						
Firing ohmmeter													-						

	Prepare the drilling	Organize the drilling	Inspect and maintain drilling equipment and accessories	Develop the drilling pattern	Mark the drilling points	Prepare the drill for the work	Drill with a pneumatic or hydraulic drill	Drill with a "down the hole" drill	Drill with a hand-held air drill	Replace broken or stuck drill rods	Drill with a winch	Organize the blasting	Inspect and maintain the blasting equipment and accessories	Load the drill holes (electric initiation)	Load the drill holes (non-electric initiation, with or without a detonating cord)	Load the drill holes (electronic initiation)	Extend the lead wire	Fire the explosives	Inspect the blast area
Blast barrier													-						
Crimpers													-						
Starting punch													-						
Propane gas tank and torch													-						
Seismograph													-						
LIGHT ACCESSORIES AND EQUIPMENT																			
Safety chain													-						
Chain													-						
Safety whip													-						
Extractor (concave or convex)													-						
Sealing joints													-						
Lead wire													-						
Air line lubricator													-						
Air hose repair kit													-						
Identification sign													-						
Hand shovel													-						
Adapter													-						
Coupling system													-						
Drill rod													-						
Drill bit													-						
Air hoses													-						

	Prepare the drilling	Organize the drilling	Inspect and maintain drilling equipment and accessories	Develop the drilling pattern	Mark the drilling points	Prepare the drill for the work	Drill with a pneumatic or hydraulic drill	Drill with a "down the hole" drill	Drill with a hand-held air drill	Replace broken or stuck drill rods	Drill with a winch	Organize the blasting	Inspect and maintain the blasting equipment and accessories	Load the drill holes (electric initiation)	Load the drill holes (non-electric initiation, with or without a detonating cord)	Load the drill holes (electronic initiation)	Extend the lead wire	Fire the explosives	Inspect the blast area
SMALL TOOLS AND ACCESSORIES																			
Galvanometer battery													-						
Mining exploration drill plugs													-						
Tamping rod													-						
Toolbox													-						
Monkey wrench													-						
Connecting wire													-						
Grinding wheel													-						
Paint													-						
Fishing tool													-						
Measuring tape													-						
Pail													-						
SAFETY ACCESSORIES AND EQUIPMENT																			
Anchor for the worker													-						
Fall-prevention device													-						
Safety boots													-						
Ear plugs													-						
Lifeline													-						
Safety belt													-						
Hard hat													-						

	Prepare the drilling	Organize the drilling	Inspect and maintain drilling equipment and accessories	Develop the drilling pattern	Mark the drilling points	Prepare the drill for the work	Drill with a pneumatic or hydraulic drill	Drill with a "down the hole" drill	Drill with a hand-held air drill	Replace broken or stuck drill rods	Drill with a winch	Organize the blasting	Inspect and maintain the blasting equipment and accessories	Load the drill holes (electric initiation)	Load the drill holes (non-electric initiation, with or without a detonating cord)	Load the drill holes (electronic initiation)	Extend the lead wire	Fire the explosives	Inspect the blast area
Security fence													-						
Ear muffs													-						
Fencing rope													-						
Rope with grab													-						
Absorbent layer													-						
Smock													-						
Carbon monoxide detector													-						
Bib													-						
Fire extinguisher													-						
Work gloves													-						
Harness													-						
Raincoat													-						
Explosives transport itinerary													-						
Safety glasses													-						
First aid kit													-						

Grid of Occupational Health and Safety Elements

Produced by: **Lauréat St-Pierre, Inspector**

Commission de la santé et de la sécurité du travail

Table A.2 Hazards and Means of Prevention in the Blaster-driller Occupation

No.	Hazards	Effects on Health and Safety	Means of Prevention
1	Chemical hazards • Gases • Smoke • Dust	• Irritation • Intoxication • Headaches • Nausea • Dizziness • Confusion • Respiratory disorders • Cardiac disorders • Loss of consciousness • Cancer • Coma • Death	• Refer to the manufacturer's technical sheets and material safety data sheets (MSDS) / train the workers. • Choose products while taking into account the locations where they are used. • Use high explosives / fume class 1. • Packaged explosives / water resistant / high detonation. • Remove overburden, paving and snow. • Establish a procedure for removing blasting mats in the blaster's absence. • Remove the blasting mats in the minutes following the blast. • Delay the drillers' presence after the blasting mats have been removed. • Excavate the blasted ground. • Ventilate the area naturally or mechanically. • Maintain the various contaminants under the values prescribed in Schedule 1 of the IRSST. • Extract dust at the source. • Drill with a water supply. • Wear respiratory protection equipment according to the guide of respiratory protection equipment (IRSST).

No.	Hazards	Effects on Health and Safety	Means of Prevention
2	Physical hazards - Noise - Vibrations	- Hearing loss - Loss of balance - Fatigue - Stress - Decreased vigilance	- Choose appropriate machinery for the tasks and premises. - Maintain the machinery according to manufacturer recommendations. - Comply with the provisions of SCCI section 2.10.7 (noise level / exposure time). - Use hearing protection (ref. CSA- Z94.2-1974 applicable at the time of its manufacture).
3	Physical hazards - Electricity (overhead or underground lines) - Electricity (machinery)	- Shocks - Electrical burns (internal and external after-effects) - Electrification - Electrocution - Death	- When the lines are underground, ask the energy distributor for their location. - Obtain an understanding and agreement with the energy distributor. - Turn the electric lines off. - Isolate the lines. - Observe approaching distances under SCCI Division 5 or according to the energy distributor's written instructions. - Turn off the machinery, equipment and tools to be repaired. - Ensure grounding of the equipment before its use.
4	Physical hazards - Intense heat - Intense cold	- Dehydration - Loss of vigilance - Dizziness - Nausea - Confusion - Loss of consciousness - Death - Frostbite - Hypothermia - Decreased vigilance - Amputation - Confusion - Loss of consciousness - Death	- Wear appropriate clothing for the tasks and weather conditions. - Get hydrated regularly. - Adapt the work schedule (e.g.: heavy tasks at the beginning or end of the day). - Reduce the pace and workload. - Take more breaks and lengthen them. - Wear appropriate clothing for the tasks and weather conditions. - Have spare clothing (clothing must stay dry). - Take the wind factor into account. - As necessary, take breaks in a heated shelter. NOTE: In intense heat or cold, one must be vigilant at all times and be concerned about one's co-workers (watch out for unusual behaviour).

No.	Hazards	Effects on Health and Safety	Means of Prevention
5	Ergonomic hazards - Stressful postures - Frequent handling - Excessive efforts	- Physiological effects - Musculoskeletal disorders - Discomfort - Fatigue - Pain - Tendinitis - Bursitis - Sprains - Strains - Hernias	- Adopt a comfortable working posture. - Regularly change the working posture. - Vary the tasks. - Distribute tasks among the workers. - Lighten the loads. - Reduce load-carrying distances. - For heavy loads, use an appropriate lifting system and obtain assistance from other workers. - Take short breaks frequently.
6	Safety hazards - Risk of being stuck, collided with, hit or crushed when: - moving machinery - getting machinery on and off the float - moving on unstable, slippery or sloping ground - positioning the machinery - using lifting devices NOTE: The machinery includes all machines used, whatever the type of energy required for its operation.	- Bruises - Contusions - Fractures - Amputations - Multiple injuries - Permanent physical or psychological after-effects - Death	- Recognize, according to the tasks to perform, the areas where workers risk getting stuck, collided with, hit or crushed. - Determine a safe access road. - Remove from the chosen access road any hindrances that may cause, notably, the machinery to slide or overturn when moved. - Determine safe workstations when machinery is moved, for example opposite the movement of machinery, on the uphill side of a slope, at a safe distance from the machinery. - Use safe methods and techniques to hold in place and guide machinery (installing anchors, a winch and cables). - Use means for stabilizing and holding in place the machinery (outriggers, shims, cables, anchors, winch). - Make sure at all times to be visible to the operator. - Use appropriate lifting devices (crane, boom truck, hydraulic shovel). - Use a load attachment device designed to prevent any accidental detachment. - Check the condition of any lifting equipment used (slings, hooks, shackle). - Maintain constant communication during all tasks (communicating verbally, visually or with signals). - Frequently wear and use prescribed personal protective and safety equipment: hard hat, safety footwear (class 1), gloves, bib.

No.	Hazards	Effects on Health and Safety	Means of Prevention
7	Safety hazards • Access to moving machinery and parts • Failure, rupture or break caused by inadequate mechanical strength (including the use of steel cables) • Failure, rupture or bursting caused by an accumulation of pressurized energy (hydraulic, pneumatic)	• Bruises • Contusions • Lacerations • Cuts • Open wounds • Strains • Sprains • Fractures • Burns by friction, with hot parts or fluids • Eye injuries • Amputations • Permanent physical or psychological after-effects • Death	• Every machine must be designed and built to make dangerous areas inaccessible, otherwise it must be equipped with protective devices. • The emergency stop device must be visible to the worker and within his reach. • Use machinery, tools, equipment and accessories according to manufacturer prescriptions and recommendations. • Maintain the machinery, tools, equipment and accessories according to manufacturer recommendations. • Machinery, tools, equipment and accessories must be maintained and repaired by qualified persons. • Replacement of parts of on machinery, tools, equipment and accessories must be done with parts authorized by the manufacturers or of equivalent quality. • Train and supervise the worker so that he has the knowledge and skills to do assigned work safely. • Maintain a machinery maintenance log. • Make the usual verifications before starting machinery, tools, equipment and accessories. • Detect leaks, fissures or any anomaly in the systems. • Ensure that all personal protective and safety equipment recommended by manufacturers is in place (collars, flanges, attachments, safety whips). • Use machinery, tools, equipment and accessories according to manufacturer recommendations. • Consult pressure gauge data regularly. • Quickly detect noises, vibrations and odours that differ from those usually perceived during tasks. • Make repairs when energy is at zero. • Purge the hydraulic and pneumatic systems. • Ensure that no part can be reactivated in any way during repairs. • Enter in the log any anomaly detected, repairs made and required maintenance, before reusing machinery (tools and equipment). • Make sure a first-aid is present. • Have a first aid kit (including a first aid manual) on the premises.

No.	Hazards	Effects on Health and Safety	Means of Prevention
			• Have fire extinguishers. • Wear and use prescribed personal protective and safety equipment: hard hat, safety glasses, safety footwear, gloves, hearing protection, clothing that covers the entire body (adjusted at the ends).
8	Safety hazards • Loss of balance • Risk of slipping • Risk of falling • Same-level fall • Fall from over three metres	• Bruises • Contusions • Sprains • Strains • Fractures • Multiple injuries • Permanent physical or psychological after-effects • Death	• Locate and use safe access roads. • Free workstations from any hindrance and obstacle. • Use equipment provided or prescribed for raising or lowering machinery, and observe the three point rule at all times. • Use abrasives on icy surfaces. • Use absorbent materials on oil-contaminated surfaces. • Delimit a safety parameter (cables, barricades, fences) approx. three metres away from the open sides of any excavation wall where workers are exposed to the hazard of falling more than three metres. • Know and apply the emergency measures prescribed by the prevention program, so that ambulance attendants can arrive quickly on the premises and evacuate an injured worker to a hospital. • Develop and test a rescue procedure for taking only 15 minutes to release any worker who, after falling, is suspended in a safety harness. • Wear and use prescribed personal protective and safety equipment: safety footwear with non-slip soles, hard hat, safety harness, and all accessories and devices prescribed in section 2.10.12 of the Safety Code for the construction industry. • Make sure a first-aider is present. • Have a first aid kit less than five minutes away.

No.	Hazards	Effects on Health and Safety	Means of Prevention
9	Safety hazards • Explosion, either unexpected or according to the firing plan • Handling explosives • Lightning • Electric current • Shocks • Sparks • Projection of stones • Electric / non-electric firing	• Lacerations • Fractures • Amputations • Multiple injuries • Permanent physical after-effects • Psychological trauma • Death	• Rigorous application of the laws and regulations for handling and using explosives. • Rigorous application of safe working methods recognized by the industry. • Explosives and blasting accessories must be protected at all times against shocks, heat, sparks and flames. • The blaster must monitor and be responsible for the explosives at all times. • Choose explosives and blasting accessories according to the type of rock and the construction site's condition. • Check the condition of explosives and blasting accessories. • Check firing accessories (lead wire, batteries, exploder, galvanometer). • Determine the loading area's perimeter. • Evacuate beyond the perimeter any construction site machinery and equipment, as well as unauthorized persons, before removing explosives from the magazines and loading the drill holes. • Remove from the magazines only the quantity of explosives and blasting accessories required according to the firing plan. • Check the blastholes' straightness before loading. • Flush out the blastholes. • Check with the driller whether the holes drilled have peculiarities (rock hardness, emptiness, etc.). • Adjust the loading of holes according to the circumstances and enter those data in the firing log. • Prepare the primer cartridge only at the moment of initiating the blasthole. • Use non-ferrous tools. • Ensure the loading column's continuity. • Observe the collar height prescribed by the firing plan. • Use clean stone for tamping (½ in. to ¾ in.). • Observe SCCI prescriptions when using the method of immediate loading; notably: – maintain a distance of over five metres between the explosives and the drill; – load and drill alternately.

No.	Hazards	Effects on Health and Safety	Means of Prevention
			• Connect detonator wires / connect shock tubes or surface timers according to the firing plan. • Check all circuits. • Protect surface connections before putting blasting mats in place. • Store surplus explosives and blasting accessories in jobsite boxes (which must be locked). • Place the blasting mats (which must not be slid). • Delimit an appropriate safety perimeter for the firing to be done. • Evacuate the loading area. • Test the lead wire. • Short-circuit the lead wire. • Check the entire circuit. • Ensure that the blast area is evacuated (machinery, equipment, persons). • Ensure that the guards are at their post. • Signal the firing (signals reserved for blasts). • Make sure to have received from the guards the confirmation to proceed with firing. • Disconnect and short-circuit the lead wire. • Have fire extinguishers nearby. • Use prescribed personal protective and safety equipment: hard hat, safety footwear, hearing protection, eye protection, gloves, etc. • Look for misfires. NOTE 1: If necessary, untamping and reinitiating must be done according to SCCI prescriptions in effect at the time of application. NOTE 2: Explosives must be destroyed according to manufacturer recommendations.

No.	Hazards	Effects on Health and Safety	Means of Prevention
10	Psychosocial hazards - Intensification of work, due to: - constraints regarding deadlines, costs, the environment and weather conditions - a supervisor, a client - poor mastery of tasks to be performed - psychological harassment or verbal and physical violence	- Sleeping disorders - Depression - Psychosomatic illnesses or physical pathologies (backaches or limb disorders) - Psychophysiological effects - Mental overload, stress, difficulty analysing problems encountered, difficulty in decision-making - Difficulty planning and organizing one's work, in logical progress, despite a known sequence of tasks to be performed	- Adopt a healthy and balanced lifestyle (work, rest, family, friends, leisure, diet). - Limit yourself to responsibilities related to the tasks (cost and scheduling constraints belong to another hierarchical level). - Know in advance from your supervisors the amount of work required for your work shift. - Plan your work according to requirements, while taking into account your limitations, the constraints of the environment, weather, the condition of machinery, equipment and available materials. - Inform your supervisor of information that you know and that he may not have taken into account. - Adopt and improve safe work methods recognized by the industry. - Take relevant training to perfect techniques and work methods, in order to master all the tasks to be performed. - Report any form of violence and harassment to the appropriate authorities. - If applicable, recognize psychological hazards and consult a health professional.