

## FRENCH REGULATION 1992 FOR HYPERBARIC WORKS

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### I - INTRODUCTION

As soon as the shield tunnelling boring machines (TBM) started to work in France in the 80's, the décret July 9, 1974, concerning safety rules for compressed air workers proved to be poorly adapted to this new technology.

Very soon after the publication of the French décret July 11, 1974, concerning safety rules applicable to commercial divers, it appeared that the rules would need improvement. The developing offshore industry asked for more detailed and better adapted legislation.

As already announced (Le Péchon et al. 1989) a new French regulation have been published (décret March 21, 1990) and has received additional arrêtés in 1991 and 1992. A few more are expected in 1993.

This new regulation is based on the "Code du Travail" and it is in agreement with the law (December 31, 1991) which transcribes the European Directive dated June 12, 1989 on health and safety at work.

The general organization of the Health and Safety at work regulation in France is shown on table n° 1.

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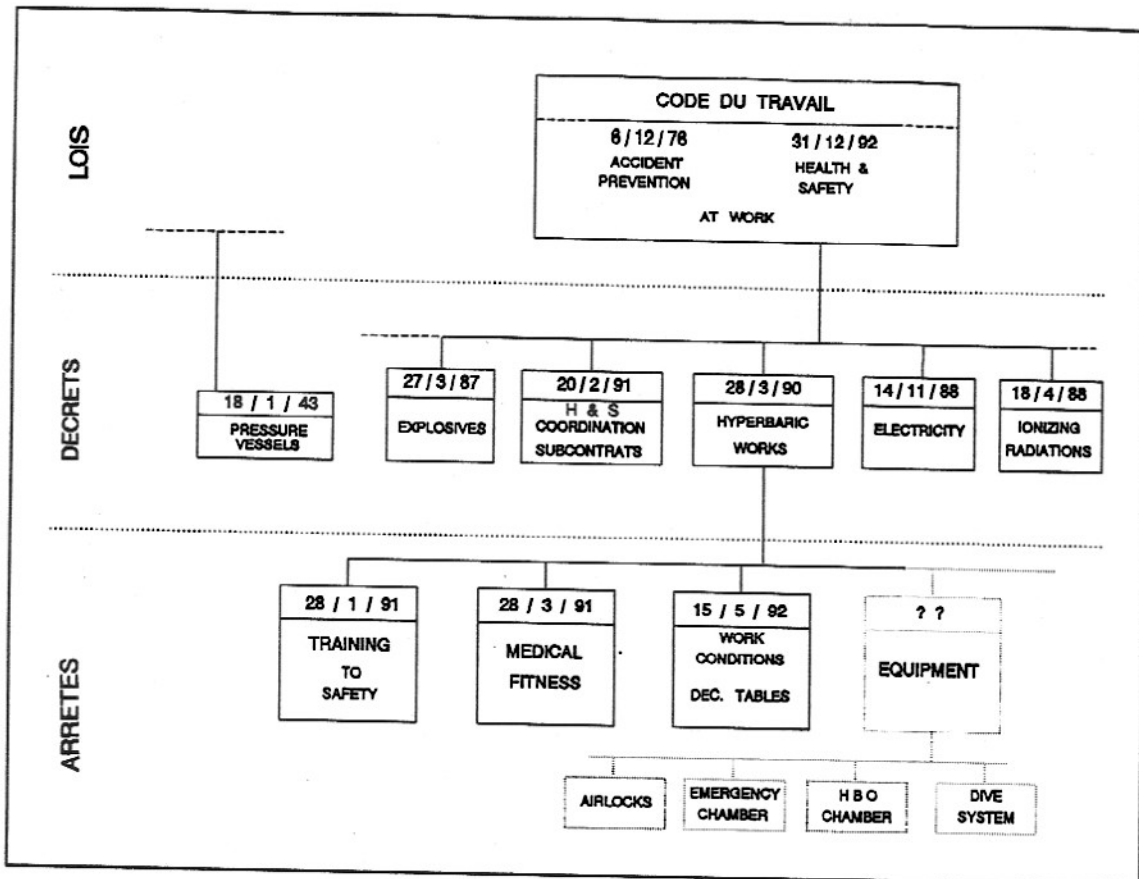


Table n° 1 : Health & Safety - French regulations diagram

## II - DECRET FEBRUARY 20, 1992 - COORDINATION OF H & S IN SUBCONTRACTS.

For diving activities, the décret for the coordination of Health and Safety between a company and its subcontractors, is of major importance since most of diving works are carried out by underwater contractors.

This décret stipulates in particular :

- 1 - The company is responsible for the initiation and the coordination of health and safety measures applicable in its own sites.
- 2 - Each employers remains responsible for its own personnel's Health and Safety.
- 3 - A "Plan de Prévention" must be prepared and agreed upon by both parties addressing all health and safety points which may interfere on site and this is to be understood on a wide basis. The "Plan de Prévention" is also to be approved by employees representatives.

### III - DECRET MARCH 28, 1990 : PREVENTION MEASURES FOR HYPERBARIC WORKS.

#### 3.1 - WHO IS CONCERNED ?

This décret is specific for hyperbaric works and makes no reference to the various professions or activities which lead to expose personnel to hyperbaric situations, in immersion or in the dry, the field of application is very wide :

"Any body exposed, at work, to an increased pressure above 0.1 bar relative to local pressure, needs to be protected against the possible harmful effects of pressure, and when applicable immersion, according to this décret requirements".

It is therefore applicable to professional divers of all sorts :

- Commercial oilfield divers,
- Commercial onshore divers,
- Scientific divers (biologists, archaeologists...),
- Film industry, TV reporters etc... divers,
- Professional diving instructors,
- Divers involved in aquaculture,
- Divers on board fishing vessels,
- etc...

and to compressed air workers :

- In tunnelling boring machines,
- Compressed galleries operations,
- Hyperbaric testing of nuclear plant confinement structures,
- In attending patients during Hyperbaric oxygen therapy exposures
- Submerged caisson works,
- Experimental dry chamber exposures,
- Dry transferred hyperbaric subsea welding operations

This décret does not apply to professions but to the physical risks associated with living under pressure.

## 3.2 - CONTENT OF THE DECRET

### 3.2.1 - Breathing gases quality standards

#### Compressed air authorized until 6 bar(g)

##### Limits on partial pressures

Carbon dioxide CO <sub>2</sub> :	10 hPa = 10 mb
Carbon monoxide CO:	0,05 hPa = 50 µb = 5 Pa
Water vapour H <sub>2</sub> O :	In saturation 60 to 80 % relative Humidity
Volatil hydrocarbons :	0.5 mg/m <sup>3</sup> (m <sup>3</sup> measured at pressure)
Dust, other pollutants :	Standard Threshold Values expressed in partial pressures
Nitrogen N <sub>2</sub> :	5.6 bar - air at 6 bar(g) -
Oxygen O <sub>2</sub> :	> 0.160 hPa
In water :	< 1.6 bar and less according to the duration of exposure
Chamber Decompression :	< 1.2 bar
Saturation atmosphere :	0.3 to 0.45 bar
Emergency recompression:	< 2.8 bar
Fire prevention (FO <sub>2</sub> ):	< 25 % by volume in atmosphere

##### Procurement, responsibility and controls

- Selection of proper gas : - Employer's responsibility
- Quality control :
  - Gas supplier (analytical data to be supplied with delivery)
  - Employer if gas mixed on site
  - Oxygen control mandatory (except for air diving)

### 3.2.2 - Personnel requirements

Training to safety for the various hyperbaric situations, is mandatory for all concerned personnel undergoing pressure exposures, with various levels of training objectives (arrêté March 28, 1991).

In addition,

- A competent person nominated in writing by the employer must look after the operation and be ready to take any action required for the safety of the personnel (Chef d'Opération Hyperbare).

- A competent person nominated in writing by the employer must supervise permanently the person(s) under pressure and make sure safety rules are adhered to and that the procedure is followed safely.
- A qualified and medically fit person must be ready at any time, upon signal of the supervisor, to give assistance to the person(s) exposed to pressure and carry out rescue operation if needed. This person must hold a first aid certificate.

### 3.2.3 - Equipment and procedures

At any time equipment and procedures must allow for a possible rescue of the person(s) exposed to hyperbaric situations (consequences : Stand-by person, airlock configuration, ... system for unconscious diver recovery etc... are needed).

### 3.2.4 - Documentation

In addition to the "Plan de Prévention" when work is subcontracted, the documentation must include :

- Employer's hyperbaric safety manual
- Site safety rules and procedures
- Logging of exposures
- Personnel certificates of classification and medical fitness
- Personnel log book
- Accident reporting
- Equipment maintenance books.

### 3.2.5 - Medical fitness

The medical fitness certificate is signed by an occupational medicine doctor, who may ask an hyperbaric doctor to carry out specific examinations on his behalf according to recommendations specified in arrêté March 28, 1991.

### 3.2.6 - Working conditions and decompression tables

Working conditions are addressed in a separate arrêté May 15, 1992. Decompression tables are published as 5 separated annexes to this arrêté.

#### IV - ARRETE JANUARY 28, 1991 : TRAINING AND CERTIFICATES

There are no training certificates for superintendents (Chef d'Opération Hyperbare) or supervisors (Surveillant), they are nominated by the employer. It is the employer's responsibility to make sure that the persons he designates have received the proper training and that they are competent for the purpose.

Persons going under pressure must have a safety training certificate called "Certificat d'Aptitude à l'Hyperbarie" (CAH). There are various types of CAHs. A CAH includes a "Mention" describing the type of hyperbaric activity and a "Classe" showing the maximum pressure for which the training objectives have been achieved. Example : For a compressed air intervention at 2.4 bar, the workers must hold a CAH Mention D (eventually A or B) Classe I (eventually II or III). Table n° 2 shows the various combinations of CAHs.

Table n° 2 : TRAINING CERTIFICATES (CAH)

PRESSURE (bar)		0 à 1,2 bar	0 à 4 bars	4 à 6 bars	> 6 bars
ACTIVITIES		<i>Sous-Classe I A</i>	<i>Classe I, II or III</i>	<i>Classe II or III</i>	<i>Classe III</i>
WITH IMMERSION	INDUSTRIAL DIVERS	NA	<b>A</b>	<b>A</b>	<b>A</b>
	OTHER DIVERS	<b>B*</b> or A	<b>B*</b> or A	<b>B</b> or A	<b>B</b> or A
WITHOUT IMMERSION	MEDICAL PERSONNEL	NA	<b>C*</b> or A, B	<b>C*</b> or A, B	<b>C</b> or A, B
	COMPRESSED GAS WORKERS	<b>D*</b> or A, B	<b>D*</b> or A, B	<b>D</b> or A, B	<b>D</b> or A, B

NA = Non applicable  
 \* = Authorized Employer  
**A, B, C** = Corresponding necessary Mention

The various CAHs (with proper Mention and Classe) can be obtained from various sources:

- a - Approved training centres. The approval procedure is described.
- b - For certain categories (marked \* in table n° 2) from the employer if he has received formal authorization from the Administration. Application conditions are given.
- c - Until March 3, 1993 and only for those in activity before october 1990, an interim procedure is available to obtain a "classification from experience" through an *ad hoc* commission.

- d - Some certificates or diplomas, issued by several recreational diving organizations, military diving schools or universities, lead to the delivery of the CAH with no additional training.

All CAHs are delivered by Institut National de la Plongée Professionnelle (INPP) or behalf of the French Ministry of Labour.

## V - ARRETE MAY 15, 1992 : WORKING CONDITIONS, DECOMPRESSION TABLES

All decompression tables published have been established by COMEX. For air diving tables, evaluation, calculation and validation COMEX has received financial support of the Ministry of Industry. Validation is based on Comex dive logging system (Imbert et al. 1990, Le Péchon et al. 1992).

### 5.1 - LIST OF OFFICIAL DECOMPRESSION TABLES

#### DIVING OPERATIONS

##### AIR & NITROX MIXTURES :

- Minitable air
- Table Air / Standard
- Table air / O<sub>2</sub> / 6 m
- Table air / O<sub>2</sub> / 12 m
- Table Air / Surface decomp. / O<sub>2</sub>
- Nitrox Diving Procedure
- Multilevel Diving Procedure (ascending)
- Altitude Diving Procedure (up to 3000 m)
- Bentonite Diving Procedure
- Repetitive Diving Procedure

##### HELIOX MIXTURES :

- Table Heliox / O<sub>2</sub> / 6 m
- Table Heliox / O<sub>2</sub> / 12 m
- Table Heliox / O<sub>2</sub> / Diving Bell
- Saturation Diving Procedure to 200 msw

#### COMPRESSED GAS WORKS

##### H B O THERAPY ATTENDANTS :

- Table / Mention C / Standard
- Table / Mention C / O<sub>2</sub>

##### COMPRESSED AIR WORKS :

- Table / Mention D / Standard
- Table / Mention C / O<sub>2</sub>
- Tables for one extra bottom time.

#### EMERGENCY RECOMPRESSION

- Decompression Illness symptoms "Type I"
- Decompression Illness symptoms "Type II"

## 5.2 - WORKS IN IMMERSION

A review of the various diving situations is made. The maximum daily immersion time is specified (3 hours for commercial diving Mention A and up to 6 hours for non commercial divers mention B) as well as the duration and frequency of saturations. The minimal team content for the various diving procedures and the minimum individual equipment needed are listed.

The decompression tables to be used in correlation with diving works and published are listed above. No decompression computer is allowed for professional diving.

## 5.3 - WORKS IN COMPRESSED GASES

Maximum shift duration in compressed air is given :

- 8 hours per day if pressure is lower than 0.75 bar
- 6 hours per day if pressure is higher than 0.75 bar.

Repetitive exposure are restricted to pressures lower than 2.1 bars

The decompression tables to be used in correlation with hyperbaric works in the dry are listed in 5.1.

## 5.4 - EMERGENCY RECOMPRESSION

Based on the principle that whatever the quality of a decompression procedure used, a case of decompression illness may appear, two emergency recompression tables (for so called Type 1 and Type 2 decompression symptoms), to be used on site before the advice of an hyperbaric medical doctor is obtained, are published. The table for Type 2 cases requires the patient to breathe an heliox mixture 50/50 on mask from 3 bar(g) to 1.8 bar(g), then pure oxygen. The provision for the decompression of the attendant on pure oxygen is included.

## 5.5 - REMARKS, NEW TECHNOLOGY, ALTERNATIVE METHODS

No limitations are given for pressure exposures. When pressures or durations foreseen during a specific operation are higher or longer than those basically displayed in the decompression tables an authorization is required. To obtain this authorization an application describing the project, the safety rules and the table must be submitted to the Ministry of Labour for eventual approval.

When methods or equipment not described as standard in the arrêté are needed an application for authorization is to be made to the Ministry of Labour.

The decompression tables are published as Annexes, meaning that they will be easy to modify and improve as requested from the evaluation carried out in the field.

This legislation is open of improvements.



## 5.6 - EMERGENCY RECOMPRESSION CHAMBER

Availability of a recompression chamber is necessary for all types of situations, however time to reach this chamber is modulated according to the hyperbaric exposure contemplated.

Diving :

Decompression time is less than 15 minutes :

Mention A activities : Less than 1 hour

Mention B activities : Less than 2 hours,

Decompression time is to exceed 15 minutes : recompression chamber on site.

Compressed gas works :

Decompression time less than 15 minutes :      Recompression chamber available in less than 2 hours.

Decompression time more than 15 minutes :      Recompression chamber available in less than 1 hour.

Maximum pressure more than 1.8 bar(g) :      Recompression chamber on site.

## VI - THE FUTURE AND CONCLUSION

Still missing are the arrêtés giving the specifications for the equipment involved in hyperbaric works. For practical reasons this arrêté may have to be divided in several publications including :

- Airlocks for tunnelling,
- Emergency recompression chambers,
- Hospital walk-in HBO chambers,
- Diving systems and equipment.

These regulations are presently under preparation and review within the groups of users.

These French rules 1990-92 are based on a new approach (only Brazil has used it before), which takes into consideration the physical risks involved by staying under increased pressure. These rules cannot be departed from the context "Code du Travail" which covers the other physical risks which may become associated during hyperbaric exposures. For example : noise, electricity, fire prevention or ionising radiations and atmospheric pollution. These points are not addressed in hyperbaric regulation unless specific additional precautions are required resulting for the actual pressurized condition, it is the case for fire prevention and fire fighting or breathing gas purity standards.

This new regulation is probably not perfect, however most of the problems identified in the recent years as major issues have been addressed (Holthaus 1992). When this rules are offered to other european countries as a draft for a future European Directive for hyperbaric Health & Safety, the chosen limits, restrictions, methods, tables and recommendations will have to be discussed. Amendments will be offered for corrections and improvements as needed.

## VII - REFERENCES

### Regulations :

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