

## Engaging and training of operating staff

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The service and quality levels in the tunnel available to the user obviously depend on the nature and performances performed by the installed equipment. It also depends on the way this equipment is operated by the employed operating staff.

As a very schematic view the operating staff can be classified into two categories :

- Administrative and logistical personnel, (personnel management, salaries, purchases, book-keeping, and so on)
- Operating personnel, dealing with the structure more directly. (**Maintenance agents**, agents responsible for the control of equipment called **operators** below, and **rescue team staffs**).

This paper only deals with engaging and training of the second category of personnel.

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### 1 Selection and training of the operating staff

The tasks performed by the maintenance agents, operators and intervening staffs is of major importance; therefore the people called to perform these duties must be :

- well selected when engaging,
- well trained before starting their tasks,
- well followed-up all along their career.

### 2 Operating context in several countries

In many countries like The Netherlands, Sweden and Norway the tunnels on the highways are government property. A contractor normally maintains both the tunnel and the traffic installations, but the installations are operated by the public roads administration itself.

Incident management are done different differs depending on national regulations and in some countries also on practical issues dependant on local conditions from tunnel to tunnel. Police and fire brigades are in many countries only attend on request of the tunnel operator taking responsibility for their appropriate authorised tasks (management of fire / legal issues caused by the incident ). In some tunnels because of practical issues tunnel alarm systems are routed directly to the fire department.

French tunnels are government property or local administration property. They could be tolled or un-tolled. The table below gives some facts about the situation in France, which differs from many other countries.

	Un-tolled tunnels		Tolled tunnels
	On national roads	On local roads	
Maintenance	By contractor or by National Road Administration	By contractor or by local Administration	By contractor or concessionaire
Traffic operation (from control centre)	By Police	By Police	By concessionaire
Management of the tunnel and traffic installations	By National Road Administration	By local road Administration	By concessionaire
Planning of maintenance	By National Road Administration	By local road Administration	By concessionaire
Incident management (help with accidents)	By Police and possibly National Road Administration	By Police and possibly local road Administration	By concessionaire and Police
Fire brigades are only coming on request of the tunnel operator and take responsibility for their proper task (management of fire / juridical part of accident).			

### 3 Definition of positions

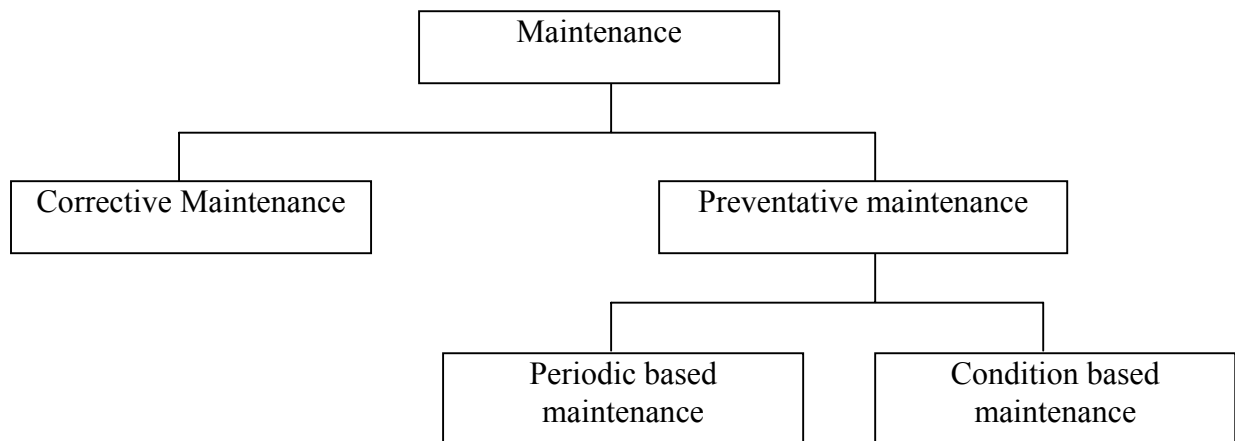
#### 3.1 Maintenance personnel

The maintenance personnel role is to intervene on the technical facilities of the tunnel(s), in a preventive and corrective way.

At the time of installation, the tunnel equipment must operate to the design intent. To achieve this, objective actions must be initiated, aiming at maintaining or re-establishing this equipment to a specified state or to conditions proper to ensure a defined service; all these actions are known as maintenance.

Maintenance can occur in different ways :

- Preventative: maintenance occurs according to pre-determined criteria (periodic frequencies or specific conditions) ;
- Corrective: maintenance occurs after or approaching equipment failure.



### 3.1.1 Required technical skill

The Table below gives a non-exhaustive list of the maintenance tasks that might be encountered in a tunnel. The actions are classified by order of maintenance level<sup>1</sup>, by nature of task, by type of task, with a qualitative indication on their technique.

Maintenance level	Task nature	Task type	Required technical skill <sup>2</sup>
1	Current maintenance	Washing Cleaning Lubrication Painting, etc.	Very low
2	Tests/Controls (accessible) <sup>3</sup>	Manual control transmission Survey of displayed values Control or pilot lamps and failure indicators	Low
	Tests/Controls (less accessible)	Electric measurements (voltage, intensity, frequency, harmonics, ...)	Mean
3	Scheduled interventions (sub-systems)	Standard exchange of a part of the equipment (filters, display lamps, pilot lamps, electronic cards, etc...)	Mean
	Scheduled interventions (complete equipment)	Standard exchange of an equipment (collection sensors, measuring devices, etc...)	Mean to high
4	Breakdown service (standard equipment)	Breakdown analysis, diagnosis and repair (low voltage circuit, electric boards and engines, etc...)	High
	Breakdown service (complex equipment)	Breakdown analysis, diagnosis and repair (high voltage cells, data networks, automats, electronic boards, etc...)	Very high
5	Restoration, Rehabilitation	Any equipment type	Very high

The higher the tasks technique, the higher the technical expertise of the personnel responsible for these tasks must be (from the operator to the engineer). It should be noticed that level 5

<sup>1</sup> Classification according to the elements supplied by French Standard X 60-010 "Maintenance – Concepts and definitions of maintenance activities"

<sup>2</sup> In all cases, intervening people must be entitled and trained for the various possible sorts of work.

<sup>3</sup> The maintenance agent has not to open boards of electrical boxes

(restoration, rehabilitation) does not belong to the operating society but rather to the builders and manufacturers.

### 3.1.2 Subcontracting policy

In a very schematic way, the tunnel operating society gives the following choice :

- No subcontracting ;
- Partial subcontracting ;
- Complete subcontracting.

In the first case, the operating organisation will have all required skills available among its personnel, this being a difficult and costly obligation; in the third case the operating organisation is likely loose the basic knowledge of the tunnel systems and how to operate its equipment.

The current practice among the tunnel operating organisations in France therefore is to call for a partial subcontracting:

- either committing tasks of a certain level to outside organisations and keeping the remaining ones inside the operating organisation. In this case, according to skills available now or in the future, the operating organisation may subcontract works of low technical level (cleaning, washing, etc.), thus meaning that this organisation employs maintenance staff able to ensure high technical tasks. Also, on the contrary, the low technical level works (washing, visual controls, data collection, etc.) can be ensured by the operating organisation and the high technical level tasks that are entrusted to outside companies.

Maintenance levels	Advantage(s)	Inconvenience(s)
Lower level(s): level 1 and even 2	Does not require agents with highly specialised expertise	Requires to use subcontracting without real possibility to control it
Higher level(s): Level 3 and even 4	Subcontracting low technical tasks  Good control of the subcontracting companies  Internal expertise, therefore relative autonomy	Requires agents with highly specialised expertise

- either subcontracting the complete maintenance of one or several equipment groups (e.g. remote traffic control, radio re-transmission, and automatic incident detection system). This procedure is frequently used when the operating organisation includes among in its equipment a high technology system that cannot be the responsibility of anyone else other than the designer (or manufacturer) of the product.

### **3.2 Control centre operators**

As a general rule the control centre operators are responsible for with the following duties:

- Traffic control inside and in the vicinity of the structure
- Detection of any event likely to endanger the users' safety. When detecting such an event the personnel – according to the guidelines – has to start the available safety elements (signalling, ventilation...), and also to inform the competent safety teams according to the severity level of the event
- Alarm given to the maintenance staff in case of failures, mal-function of the technical facilities which may have an impact on the tunnel safety.

These missions are expressed by various tasks:

- Traffic management under current operation and in case of incidents or accidents
- Control of equipment operation
- Communication with the users (Emergency Call Network, radio re-transmission, Variable Message Signs, etc.)
- Systematic contact with the intervening agents
- Call for outside services (fire staff, police, breakdown service staff, etc.)
- Contact with the other authorities (Centre of traffic management of higher level, hierarchical head, standby duty)
- Maintenance data collection in case of breakdown and follow-up of the initiated responses
- Management of interventions in the tunnel (tunnel closing, light markers).

### **3.3 Intervening External Agent**

As a general rule, the missions assigned to the external agent organisations are as follows:

- to ensure the protection of the users involved in an incident in the tunnel
- to quickly intervene in case of an incident to ensure initial safety measures are initiated and also to prepare access for the rescue team
- to remove broken down vehicles or vehicles involved in an incident outside the tunnel
- in case of a fire, to ensure the introduction of preliminary procedures to fight the fire (extinguishers).

These responsibilities are expressed by various tasks:

- illuminating the incident or accident zone according to the defined procedure
- informing the operators on the situation
- informing the users on the situation
- giving instructions to the users on the recommended behaviour
- requesting assistance from internal teams for support if required

- requesting the intervention of rescue staff if required
- facilitating the access for rescue teams
- informing the rescue teams on the situation of the incident .

## **4 Engaging Recruitment**

Whatever field of activity, the recruitment of quality staff can be considered only if :

- the tasks and missions in relation to the position to be filled are defined as precisely as possible,
- the required qualities and expertise are well identified.

### **4.1 Maintenance team**

The skills required for the maintenance team are defined more as a technical knowledge in specialised fields than as specific human qualities. Obviously the agents charged with maintenance must show a sense of responsibility, be able to work in teams, to take actions, but their technical skills are predominant among the criteria selected to fill a position in this field.

The facilities installed in a tunnel are extremely varied: power supplies, lighting, ventilation, remote control, telephony, etc. Consequently, maintenance involves various professional trades, such as: electrician, electro-mechanic, electronics engineer and automatics engineer. During previous years the electronic components and sub systems have increasingly been used in the tunnel engineering assets. This increasingly important presence of electronic components is at the expense of the electro-mechanic systems and leads progressively to the reduction of activities in relation to electro-mechanics to the benefit of new professions (network manager, industrial informatics engineer, etc.).

Tunnel facilities have various complex and technical levels. The personnel responsible for maintenance therefore must be recruited according to:

- the technical level of the duties and responsibilities
- the agreed sub contracting policy.

### **4.2 Traffic Control Centre (TCC) Operators**

An operator in the TCC should be "cold-blooded" (calm), that is, to have good stress control, a high sense of responsibility and spirit of decision. These personal qualifications are at least as important as their standards of training. However, due to technical level of the installed facilities, it is likely that staff profiles with a technical predominance must be available.

It is also advisable to consider the specific characters of the structure(s) that must be managed:



- number and complexity of the existing facilities
- traffic nature and density
- characteristics of the structure (urban or non urban, one or two tubes, etc.)
- border tunnel
- etc.

The Table below shows the French practice in this area and gives the various training levels<sup>4</sup> with their respective advantages or inconveniences.

Level	Advantage(s)	Inconvenience(s)
Technical diplomas lower than bachelor's level	Long time before discovering that this profession does not increase job prospects	Rather long training  Training course required to understand the operating mode of some facilities  May have some difficulties in understanding some complex systems
Technical bachelor's level	Level well-adapted for control the facilities to be operated	Shortest training time
2 years of technical studies after the bachelor's diploma	Accelerated training  Very good knowledge and control of the systems he has to operate	Great risk to discover that this position is routine (dull tasks)  Risk of more frequent change of employees for this position

For an operator's position, the scholarship level we propose the most suited to the job is that of the technical bachelor diploma. This is because it will allow having a technical expertise suitable to:

- understand the requirements of the installed facilities
- have a good perception of the limits of the equipment (in performance area).

For special situations (high density traffic, long tunnel, very high density of equipment, etc.), however, it may be considered to choose a higher technical level, if possible with the knowledge of a **foreign language** (English or language of the neighbour country for tunnels near a border).

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<sup>4</sup> In France the bachelor's level is reached at the age of about 18 after 7 years of secondary courses.

Finally, it should be noted that for tunnels crossing country borders it is compulsory to know the languages of each country, whatever the diploma level of the operator may be.<sup>5</sup>

### **4.3 Intervention agents**

The duties of the intervention agents do not require any special technical knowledge. As for the operators, but at a lower level, they must have more psychological qualities (cold-blooded, easy communication ability, strictness, vigilance) than a more specialist training. These qualities are at least as important as the training level.

However, due to the formal nature of the agents' role, it seems more advisable to appoint agents already experienced in assisting or helping in rescue missions, working with organisations responsible for these activities (rescue personnel, industrial firemen, etc.).

## **5 Training**

### **5.1 Maintenance team**

The training planned for a maintenance agent working on the tunnel facilities must include the following aspects in total or in part:

- internal integration procedure including the knowledge of the services and trades present in the operating structure
- knowledge of the road network the tunnel
- knowledge of all the technical assets of the structure
- knowledge of all the facilities relating to the structure
- introduction to the existing management tools and their use
- introduction to the intervention and emergency procedures (in the control centre, in the technical/equipment rooms, in the tunnel, etc.).

In the programme proposed below allows more a preliminary knowledge of the premises than learning the trade of maintenance agent. This is logical, as noted above to choose a maintenance agent essentially based on his technical skills.

If necessary the training can be complemented with courses in other firms organisations so that the agent becomes experienced with facilities unfamiliar to him or which are very complex.

At the end of the training course, the agent is able to start maintenance intervention. However, a more experienced organisation must manage him for some weeks. The organisation can access when the new agent can intervene under the same conditions as his colleagues.

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<sup>5</sup> Ref: The Mont Blanc tunnel accident

The best way to train personnel undertaking maintenance work in new tunnel or of a refurbished tunnel is to enable them to gain experience on the different installations by working with the installation crew. If this is not possible, they should at least be part of the inspection team during the installation.

## 5.2 Operators

Due to its nature itself (to ensure the users' safety and control of the tunnel facilities) the operator trade requests that training proposed to a new agent taking over his position is more dense than that proposed to a maintenance agent. It must concern all items below (non exhaustive list):

- internal integration procedure including the knowledge of the services and trades present in the operating structure
- knowledge of the road network the tunnel belongs to
- knowledge of all the technical sites of the structure
- knowledge of all the facilities proper to the structure
- presentation of the existing tools and their mode of use
- presentation of the operating procedures (normal mode, in case of incident, in case of accident, in case of fire, etc.) and corresponding documents
- rather general courses (phone reception, written and oral communication, keyboard control, etc.)
- effective presentation (site and personnel) of the outside actors (emergency services, traffic control centre of upper level, breakdown firms, etc.)
- use of tools on non active facilities (simulator) or active consoles, however without acting the equipment, in all situations planned by the operating guidelines and the intervention and emergency plan.

After this first part of training, a double drive operation can be started. This phase can request several weeks and must occur under the permanent supervision of a tutor.

As soon as the tutor – or the person responsible for training – assumes that the reached skill level is sufficient, the new agent can start working alone.

In all cases **the training course must be several weeks long** and be developed under a permanent control followed by a final validation.

### 5.3 Intervention agents

The training planned for an intervention agent who will have to intervene on incidents or accidents in the tunnel must include the following aspects in total or in part:

- internal integration procedure including the knowledge of the services and trades present in the operating structure
- knowledge of the road network the tunnel belongs to
- knowledge of all access means to the tunnel
- knowledge of localisation of all the technical sites of the structure
- knowledge of the role of all the facilities proper to the structure
- presentation of the communication means with the operator and their mode of use
- presentation of the intervention procedures (marking of an incident, marking of an accident, alarm to the operator, alarm to the emergency teams, etc.)

If required, this training can be complemented with courses on :

- communication, to provide the agent with minimal tools allowing him to control some behaviours that can be expected from the users (refusal to follow the given advices, panic, claustrophobia, etc.) ;
- first aid :
- operation of extinguishers, even individual breathing devices.

At the end of the training course the agent is able to start interventions in tunnel. However, he will preferably be associated to a more ancient colleague for some weeks. When this latter assumes that tutorship is not necessary any more, the new agent can intervene under the same conditions than his colleagues.

## 6 Ongoing training

Skills of agents responsible for operation must be maintained and improved, especially through ongoing training<sup>6</sup>.

### 6.1 Maintenance agents

Ongoing training can be provided to the maintenance agents during their activity period under several forms:

- technical courses on new facilities or recent technologies; this type of course can also be considered to develop the skills level of some agents
- formalisation of the skills exchange to ensure evolution of the procedures
- a systematic analysis of those situations leading to have some equipment frequently broken down, so that a connection can be made between the quality of the provided maintenance and the resulting reliability.

### 6.2 Operators

Ongoing training can already occur within their current activities, imposing them to make at intervals operating tests on the various facilities used in the tunnel. These tests can be conducted near the facilities, acting the local commands, thus allowing the operators to recollect the characteristics of the facilities (role, locations, performances, etc.). These tests can also be conducted from the control room through go-stop orders from the consoles; this allows the operators to revive their memory of command orders for some facilities rarely used under normal operating conditions.

Despite this, after some time, every operator has got such a knowledge of his trade that he is able to know how to react under recurrent situations (breakdowns, disturbed traffic, etc.) and does not consult the procedures any more; then, little by little, he will forget some actions, and principally loose the reflex to consult the procedures when an unusual situation occurs. It is therefore necessary to revise the knowledge of procedures at intervals.

These sessions of procedure revision must be followed by a control ensuring that the level of each operator meets the imposed requirements.

These “level restoring” sessions can also be used to evaluate and develop the procedures. As a matter of fact, in spite of any care brought to the elaboration of procedures, it cannot be

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<sup>6</sup>

In France a regulatory text (Appendix 2 to the inter-ministry circular No.2000-63 concerning safety in the tunnels of the national highways network) mentions on paragraph 5.3 that “*The skills of those responsible for operation and emergencies shall be maintained and improved by ongoing training and the organisation of exercises*”.

denied that the best validation is acting under actual facts: it is therefore necessary to install a follow-up procedure, implying the operators since they are the first users and must report on the adequacy of a procedure to a given situation or contrarily on some defects they could establish.

It must be stated that these “level restoring” sessions are not aimed at questioning the existing procedures systematically, but that they are a good opportunity to take into account the lessons from the operator skills.

Lastly it should be noticed that procedures can also be improved via the lessons from the various exercises<sup>6</sup>, actual or on simulator, conducted with or without the safety services.

### 6.3 Intervention agents

Ongoing training provided to the intervention agents during their activity period must include systematically “level restoring” sessions:

- for first aid
- for a systematic analysis of the situations in which obvious dysfunction or important delay appeared.



## Conclusion

The skills required for operating staff are very different :

- for the maintenance team they are mainly defined as a technical knowledge in specialised fields
- for the Traffic Control Centre operators they are mainly specific human qualities,
- for the intervention agents they don't require any special technical knowledge but, at a lower level than the operators, they must have psychological qualities.

The people called to work in operating tunnel must be well followed-up all along their career ; all the steps are very important : the selection, the training and the ongoing training.

One serious problem that the operator often faces is that the opening date often is fixed early in the construction phase. If there are some delays, this may result in a too short training and testing period. **It is of the utmost importance to the safety of the tunnel that this period is made long enough to give a satisfactory education to all persons involved, even if it results in a delayed opening.**

