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Durability of wood and wood-based products — Criteria for hot air processes for curative uses against wood destroying organisms

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National foreword

This Published Document is the UK implementation of CEN/TR 15003:2012. It supersedes PD CEN/TS 15003:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/515, Wood preservation.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Durability of wood and wood-based products - Criteria for hot air processes for curative uses against wood destroying organisms

Durabilité du bois et des matériaux dérivés du bois - Critères s'appliquant aux procédés à air chaud à usages curatifs contre les organismes lignivores

Dauerhaftigkeit von Holz und Holzprodukten - Kriterien für Heißluftverfahren zur Bekämpfung von Holz zerstörenden Organismen

This Technical Report was approved by CEN on 13 August 2012. It has been drawn up by the Technical Committee CEN/TC 38.

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Contents

Foreword

This document (CEN/TR 15003:2012) has been prepared by Technical Committee CEN/TC 38 “Durability of wood and derived materials”, the secretariat of which is held by AFNOR.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TS 15003:2005.

This Technical Report gives the criteria for hot air treatment for curative uses against wood destroying organisms. European Standard EN 14128 concerns the criteria for curative wood preservatives as determined by biological tests.

Introduction

This document should be used in conjunction with EN 14128 which describes the performance requirements for curative wood preservatives as determined by biological tests.

The need for hot air treatment for curative use against wood destroying organisms depends upon a careful diagnosis by expert, qualified specialists to determine the precise causes of the damage to be rectified. This should include the type of wood attacking organisms involved and in the case of beetles whether they are considered to be active, the environmental circumstances, the type of wood involved, the nature of the building or construction, and the structural and physical significance of the timber which is damaged or at risk of being damaged.

In particular the need for hot air treatment for curative use against the true dry rot fungus (*Serpula lacrymans*) should include the precise identification of the dry rot fungus, the environmental circumstances, especially the source and nature of any wetting, and the nature of the building or construction, including the masonry in which the dry rot fungus is present.

NOTE So far, no reliable methods exist to determine whether the true dry rot fungus in a building construction is dead or still alive, including dormant stage.

Hot air treatment for curative use should be used in an integrated way as part of a carefully prescribed strategy involving a series of actions appropriate to the particular circumstances of each case. Associated physical measures involving appropriate building works to remedy ingress of moisture and to dry out any dampness can be an essential prerequisite for the use of any process for curative use. Expert diagnosis should take into account all regional, practical, environmental, economical, safety and any other factors which may be relevant to the prescriptive decisions to be taken.

If properly done hot air treatment does not influence the mechanical properties of the timber involved. However, the temperature usually applied can influence materials other than wood.

It is not the purpose of this document to provide a specification, or even guidance in developing specifications for remedial work to eradicate wood destroying organisms. It is intended to guide specifiers, users and others in selecting and specifying hot air treatment on the basis of its effectiveness as demonstrated in accordance with the criteria given.

1 Scope

This Technical Report specifies the minimum performance requirements for hot air treatment intended for application against specific classes of wood attacking organism. It specifies the minimum performance criteria to be achieved by hot air treatment.

NOTE Until now sufficient practical experience and results of scientific tests are available only for heat treatments using hot air as a medium to increase the temperature inside building components up to a threshold lethal to wood destroying organisms. Therefore, this document is restricted to hot air treatments although other measures like, for example, radio waves or electric blankets may be useful means for limited and special applications.

This document is applicable only to hot air treatment, in so far as it is intended to cure attack by wood destroying beetles and the dry rot fungus (*Serpula lacrymans*).

This Technical Report is not applicable to eradicate an attack by termites or by fungi other than the dry rot fungus (*Serpula lacrymans*).

Hot air treatment as described in this document does not provide subsequent preventive protection against attack by wood-destroying organisms.

This document does not define the equipment, techniques or precise operation procedures required to achieve the parameters given in Clauses 4 and 5 for any set of practical circumstances. Specifications for particular practical circumstances have to be developed on a case by case basis by expert advisers/consultants.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
eradication
treatment of infested timber and/or masonry in order to kill the wood destroying insects and the dry rot fungus.

Note 1 to entry: An eradication not necessarily includes an preventive effect against a subsequent attack. This especially concerns hot air treatment as specified in this Technical Report and which does not include any preventive effect.

2.2
lethal dose
total amount of heat as a combination of a particular temperature for a particular period of time necessary to kill all stages of the wood destroying organisms in question

3 Wood destroying organisms

3.1 Beetles

The wood attacking beetles to which hot air treatment can be applied are:

— *Hylotrupes bajulus* (houselonghorn beetle) in the sapwood of softwoods;

— *Anobium punctatum* (common furniture beetle) in softwoods and hardwoods;

— *Xestobium rufovillosum* (deathwatch beetle) in hardwoods and softwoods, mainly in oak wood;

— *Lyctus brunneus* (powderpost beetle) in the starch containing sapwood of hardwoods;

— *Hesperophanes cinnereus* in the sapwood of hardwoods (occurs only in Mediterranean countries).

3.2 Dry rot fungus

The dry rot fungus (*Serpula lacrymans* = true dry rot fungus) occurs in buildings, causing brown rot in timber. The fungus can develop at relatively low wood moisture contents and is able to penetrate damp masonry over long distances in order to infect further timber or to develop its fruit-bodies. Typical is its capability to survive in a so-called dormant stage where it is not active but still alive.

Serpula lacrymans is very sensitive to changes in environmental conditions and can be eradicated effectively by hot air treatment.

4 Performance requirements for curative hot air treatment

4.1 General

Experience indicates that the application of heat to a particular temperature for a particular period of time under particular environment conditions, can successfully kill wood attacking organisms. This includes the various stages of beetles inside wood, that is eggs, larvae, pupae and imagos, and the hyphae of the dry rot fungus *(Serpula lacrymans)* inside wood or masonry.

NOTE In principle any form of increased temperature can be used, providing it meets the minimum requirements given in 4.3 and 4.4. However, in practice, due to technical reasons, it is not currently possible to apply high temperature sources, such as micro waves, to large components and especially not to masonry, to reach a sufficient dose of heat (temperature x time) within reasonable time by these techniques. Therefore, generally only hot air will be suitable to provide the temperatures required in the infested material.

Structural timber will generally require treatment in situ. This will generally include masonry in the case of eradication of an attack by the dry rot fungus. Suitable precautions are necessary to keep the heat close to the infested timber or masonry respectively. If necessary the components shall be covered by suitable materials, such as tents or similar equipment. In the case of the dry rot fungus provisions shall be made as to transfer the heat to the attacked building constructions as a whole which means from all sides, to confirm that the required temperature will be met and kept evenly in the entire construction. For small components or objects of non-structural timber it can be more appropriate to transport them to special treating chambers, containers etc.

4.2 Health and safety considerations

Hot air treatment carries with it significant risks of damage for example to animals and human beings, of heat sensitive materials or indeed ignition of vulnerable materials and structures. There is normally no risk of ignition of materials by the heat itself. Local fire authorities shall be consulted before setting up heat units.

NOTE It may be necessary to notify the insurers of the building to be treated and agree procedures with them as well as with the Fire Brigade.

The risk of damage depends upon the nature of the building, structure or commodity to be treated, the method of applying the hot air, the duration of the heating period and the specific material or materials associated with, or the target of the treatment.

To avoid damaging buildings and other building elements, a measuring and data collection system shall be employed which responds to the temperature and relative humidity control devices.

Contractors, specifiers, users and clients shall take all necessary measures to obtain the appropriate assurances that precautions to protect against risks have been taken and are appropriate to protect their respective interests. All relevant specific national regulations shall be followed.

Before applying curative hot air treatment in the surroundings of infested timber, it is necessary to check whether there are any animals including bird's eggs in the surroundings, which either shall be removed or the treatment shall be postponed until the animals have gone before proceeding. This refers especially to protected animals (e.g. bats).

Where heat source combustion gases are used directly to heat the structure, care shall be taken to ensure that toxic gases or oxygen depletion are not a problem.

When operators enter a heated building the effects of the hot air on them shall be considered. Personnel can need insulated protection when entering the heated zones. Operators entering a heated zone shall be monitored by others who shall be able to evacuate an incapacitated individual if necessary.

4.3 Application against beetles

The minimum temperature requirement for eradication of beetle infestation is 55 °C for not less than 60 min in the centre of each timber component. After completion of hot air treatment no ventilation shall be provided but only normal cooling down according to the natural surrounding conditions.

Hot air treatment provides no residual preventive effect. If a preventive effect is required, additional measures shall be used.

NOTE 1 Experience from practice has shown that timber of an age of more than 60 years which has been treated with hot air will normally not become attacked again by *Hylotrupes bajulus*. This observation is not valid for *Anobiidae (Anobium* and *Xestobium)*.

NOTE 2 Prevention against new infestation of timber without using chemicals may be only achieved by covering all accessible sides of the wooden components by means of physical barriers suitable to isolate the wood surface from egg-laying adults and to prevent permanently the access of insects.

4.4 Application against the dry rot fungus (*Serpula lacrymans*)

4.4.1 General

The lethal dose which will be achieved by the combination of a particular temperature for a particular period of time shall be applied to the whole extent of attack, including masonry in which the dry rot fungus normally is present.

It is important to consider all stages of the fungus, including the dormant stage, when defining the lethal dose required. The dormant but still alive stage of the fungal attack is the least sensitive to hot air.

Hot air treatment does not include any preventive effect against subsequent new attack by the dry rot fungus or any other wood destroying organism. All dry rot treatments require application of additional measures to rectify sources of moisture ingress into the building and to promote rapid drying of the structure. If such measures are not expected to be fully successful, application of wood preservatives can be required.

Hot air treatment is applicable only at locations higher than 1 m above ground level.

4.4.2 Building investigation

Prior to conducting a hot air treatment the building structure shall be the subject of a thorough survey by a qualified surveyor. The survey report shall include:

— Description of the method of investigation;

— Results of laboratory identification of samples taken to confirm the species of the wood destroying organisms;

— Horizontal and vertical drawings with descriptions of the extent of the attack; alternatively annotated photographs can be used as a record;

— Descriptions of the causes of dampness;

— Measures to rectify damp penetration;

— Measures to induce drying out;

— Measurements of the wood moisture content including a list of positions above 20 %;

— Descriptions of load bearing constructions which need to be repaired;

— Neighbouring buildings that might be involved in the full extent of attack;

— Proposal for curative actions of decay organisms other than dry rot;

— Any other important matters.

4.4.3 Hot air treatment

All parts of the construction, irrespective of the type of material, shall be exposed to a temperature of 50 °C or more for at least 16 h. Since the mycelium penetrates materials, it is important that the core of the components has reached this temperature for at least 16 h.

The hot air shall be applied from all sides of any wall inside the construction. For outer walls this means that an insulation tent has to be placed at a suitable distance from the wall allowing the hot air to circulate within the space. Partition walls, ceilings and floors surrounding the constructions to be treated can be used as a part of the tent, if the dry rot is no nearer than 1 m from these components.

NOTE 1 Heating from one side only, especially from inside for outer parts of a construction, will have the effect that the temperature near the non heated side will only reach a temperature level of about 2 °C above the surrounding temperature. Sufficient heating can only be achieved in a reasonable time by insulating the outer face of the building using high performance insulates. This can be far less expensive (and faster) than erecting a façade scaffold necessary to support an independent tent. Without an adequate insulation the core of a wall will never reach higher temperatures than the average temperature of the outdoor/indoor-climate.

NOTE 2 In order to apply a suitable treatment it is advisable to make a plan for the treatment by calculating the necessary energy flow and by simulating the process beforehand. If by this calculation the energy flow seems to be too low, more energy (that is more heating units) has to be applied otherwise time will be wasted. On the other hand if the energy flow seems to be too high, energy is wasted. In both cases the costs will be unreasonably high.

4.4.4 Preplanning and recording

The hot air treatment shall be specified on the basis of a thorough survey of the building. Quality control shall be assured by providing a suitably large number of monitoring points and collecting the core temperatures from all of them. Data shall be collected and recorded on electronic media or by other methods which can provide verifiable proof of the effectiveness of the hot air process. Data required shall include:

a) General information about the building involved;

b) Evaluation of the survey report; (Are there any parts that need to be further investigated?)

c) Species and extent of the attack to be eradicated;

d) Timetable;

e) Preventive actions and treatment of other wood destroying organisms;

f) Budget;

g) Relevant addresses (who are the responsible persons and how to reach them);

h) List of contact persons;

i) Organisation;

j) Insulation;

k) Hot air treatment;

l) Round the clock supervision depending on the demand of the local fire authority;

m) Building plans showing:

   1) Extent of insulation;

   2) Positions for measuring the temperature;

   3) Positions for blowing in hot air;

n) Tables for successive measuring of temperature in a given position at a given time.

4.4.5 Precaution against collateral damage

To avoid harmful damages on joinery timbers caused as consequence of unforeseen drying induced by the hot air process, it is necessary to monitor and control carefully the relative humidity of the heated air.

Special care shall be taken when heating structures with lath and plaster finishes or those comprising of steel/iron members in close association with brittle materials or structures; e.g. terracotta and stone cladding, ceramic tiling or glass. When plaster becomes wet as a result of water ingress, swelling takes place which breaks the “keys” that hold the plaster to the supporting frame. Heating causes a more rapid water loss in plaster than on the supports below which causes differential shrinkage and this can result in structural collapse of the plaster.

NOTE Where the finishes in a building can be particularly sensitive to elevated temperatures (e.g. lath and plaster, wood/plastic laminates, vinyl wall coverings), it may be necessary to apply heating more slowly, using lower air temperatures. Where no information on possible damaging effects on specific materials exists, it may be necessary to conduct small-scale tests in order to define the heating procedure more appropriately. This can be especially appropriate in the case of special and/or valuable finishes such as can exist in historic buildings.

5 Monitoring requirements

To control the effect of hot air treatment, a suitable equipment for measuring the temperature reached in the infested component shall be installed in those parts of the components which are likely to be most difficult to be heated. The temperature inside the respective components shall be noted at regular intervals, preferably by the usage of graphs, in order to demonstrate if the expected warming characteristic of the wooden component has been achieved. The required time in minutes for wood attacking beetles or in hours for dry rot commences from the first measurement which shows the required minimum temperature in °C has been reached.

NOTE 1 The gradient of the graphs allows to identify any leakage in the sealing of the measuring device and to judge, if the temperature measured is the one of the wooden component itself and not of the surrounding air.

Those parts of the treated object in which the minimum requirement could not be achieved shall be recorded and these parts should be treated by other means than hot air treatment.

NOTE 2 Due to details of the construction it may be possible that certain components cannot be successfully reached by the heating source, e.g. beams which are embedded in a wall and which are heated only from one side, or beams which are covered by flooring.

An example of a record for hot air treatment against wood attacking beetles is given in annex A and for hot air treatment against the dry rot fungus in Annex B.

6 Process validation

6.1 General

In order to ensure the efficacy of a hot air treatment it is important to have procedures for quality control, especially since there is no preventive effect in a hot air treatment itself. The process of hot air treatment can be pre-planned and process controlled in situ as described below. It is more difficult with other means of heat treatment, where the necessary systems for quality control do not exist so far.

6.2 Temperature control

The temperature achieved in the core of a timber component or in the case of dry rot also masonry is a result of temperature levels applied to the surfaces (surrounding temperature), but surface temperatures respond faster than the core temperature of the component. Because of differences in the response times and temperatures, measurements shall be taken within components during the process as well as in the air surrounding the components. In addition it is necessary to make measurements at various places distributed in all rooms to be treated. By this means ‚cold spots‘ can be identified early in the process and the necessary regulations of the airflow can be achieved in order to reach a homogenous temperature throughout.

It is the coldest spot that determines when the treatment requirements are fulfilled.

6.3 Equipment

Temperature sensors can be of the thermocouple type mounted in the core of the components as well as in the air to measure the surrounding temperature. To measure the temperature inside the heated timber correctly it is essential to insulate the holes containing thermocouples to prevent a false reading being taken from the air in the hole (which can be heated faster than the surrounding material).

The equipment shall be calibrated in accordance with the relevant standard in force.

6.4 Locations for measuring

Measuring points for air temperature shall be established in all parts to be treated, especially in those places in the structure which are most difficult to be heated. If the wall in question is more than 2 m in length, two measuring points shall be established.

In the case of hot air treatment against dry rot, measuring points outside the outer walls of the heated structure shall be placed at the top and bottom. In buildings with more than two floors one measuring point shall be established at a level corresponding to half the height of any tent covering the component to be treated, if relevant. The measuring points shall be placed one per 3 m to 4 m in vertical lines.

Sensors for measuring the temperature within the components shall be located close to the sensors installed for measuring the air temperature. They shall be mounted in the part of the component, in which the lowest temperature will exist during heating (thermal centre). This will not necessarily be the geometric centre.

NOTE It is advisable to place two or more sensors in the same type of component in order to recognise whether failures of the equipment to have occurred.

Measuring points shall be shown on drawings of the floor plans and cross sections of the building in question.

6.5 Time schedule for measuring

The temperature shall be measured at the beginning of the process and thereafter at regular intervals, (at least every 12 h), until the required temperature in the components to be treated has been achieved and maintained for the required time.

NOTE It is advisable to make measurements at a higher frequency in order to recognise any ‚cold spot' so that these can be eliminated by regulation of the distribution of the heating as early as possible.

The measurement shall be recorded on a case sheet, showing the time for measurement and an identification code for the measuring spots.

The last measurements shall be taken when finishing the treatment in order to provide documentation for the quality of the treatment.

Annex A
(informative)

Example of a record for monitoring the hot air treatment to eradicate wood attacking beetles

A.1 General information

Description of the object:	Timber constructed roof of a private house; ca. 7 m × 10 m square, 4 m high
Wood species:	Scots pine (*Pinus sylvestris*)
Date of treatment:	2003-06-12; 8 h 00 min to 18 h 00 min
Source of heating:	Oil burner, type xyz, abc kW
Kind of monitoring:	Thermocouples, type xyz
Parts were the minimum requirement could not be achieved:	The four basic beams embedded in the outside wall
Company:	a b c
Responsible manager:	d e f
Responsible foreman:	g h i

A.2 Installation of the monitoring instruments:

N°	Component	Place	Location
1	Beam	2nd from east	Centre of cross section, 3 m from the north end
2	Post	3rd from west	Centre of cross section, 1,5 m above floor
3	etc		

A.3 Monitoring record

(°C at the various monitoring instruments located as described above)

Time	Location in the building							
	1	**2**	**3**	**4**	**5**	**etc**		
18 h 00 min	18	18	18	18	18			
12 h 00 min	30	28	35	38	37			
14 h 00 min	40	35	42	46	46			
16 h 00 min	50	**55**	**56**	**57**	**56**			
16 h 30 min	53	**57**	**58**	**58**	**57**			
17 h 00 min	**55**	**59**	**60**	**61**	**60**			
18 h 00 min	**57**	**61**	**62**	**62**	**61**			

Signature ..... (Manager) ..... (Foreman)

Annex B
(informative)

Example of a record for monitoring the hot air treatment to eradicate the dry rot fungus (*Serpula lacrymans*)

B.1 General information

Description of the object:	Timber constructed roof of a private house; ca. 7 m x 10 m square, 4 m high
Attacking organism:	Dry rot (*Serpula lacrymans*)
Wood species:	Scots pine (*Pinus sylvestris*)
Date of treatment:	2003-06-06 to 2003-06-09
Source of heating:	Oil burner, type xyz, abc kW
Kind of monitoring:	Thermocouples, type xyz
Parts where the minimum requirement could not be achieved:	None
Company:	a b c
Responsible manager:	d e f
Responsible foreman:	g h i

B.2 Installation of the monitoring instruments

Thermocouples to measure the temperature achieved are installed in cross sections throughout the area to be treated.

B.3 Monitoring record

(°C at the various monitoring instruments located as described above)

B.3.1 Cross section A

Date	Time	Location in the building							
		1	2	3	4	5	6	7	etc.
2003-06-06	7 h 00 min	17	19	17	17	12	14	14	
2003-06-06	18 h 00 min	21	**70**	**74**	**65**	**68**	**68**	**66**	
2003-06-07	6 h 00 min	26	**70**	**73**	**67**	**68**	**68**	**67**	
2003-06-07	18 h 00 min	35	**69**	**71**	**68**	**65**	**65**	**65**	
2003-06-08	6 h 00 min	40	**71**	**74**	**70**	**69**	**69**	**68**	
2003-06-08	18 h 00 min	47	**73**	**75**	**73**	**70**	**70**	**70**	
2003-06-09	6 h 00 min	**54**	**76**	**78**	**76**	**73**	**73**	**73**	
2003-06-09	18 h 00 min	**64**	**80**	**80**	**79**	**78**	**78**	**77**	

B.3.2 Cross section B

Date	Time	Location in the building							
		1	2	3	4	5	6	7	etc.
2003-06-06	7 h 00 min	17	16	18	16	16			
2003-06-06	18 h.00 min	24	28	23	34	24			
2003-06-07	6 h 00 min	31	37	30	42	33			
2003-06-07	18 h 00 min	42	46	40	**50**	45			
2003-06-08	6 h 00 min	47	**51**	45	**53**	**50**			
2003-06-08	18 h 00 min	**54**	**58**	**52**	**59**	**57**			
2003-06-09	6 h 00 min	**62**	**65**	**59**	**64**	**65**			
2003-06-09	18 h 00 min	**70**	**72**	**68**	**71**	**72**			

B.3.3 Cross section C

Date	Time	Location in the building							
		1	2	3	4	5	6	7	etc.
2003-06-06	7 h 00 min	19	16	19	18	19	12	16	
2003-06-06	18 h 00 min	25	20	**68**	**71**	**64**	**72**	**67**	
2003-06-07	6 h 00 min	32	26	**68**	**70**	**64**	**70**	**67**	
2003-06-07	18 h 00 min	42	36	**67**	**69**	**65**	**69**	**66**	
2003-06-08	6 h 00 min	47	41	**70**	**72**	**68**	**72**	**69**	
2003-06-08	18 h 00 min	**54**	48	**72**	**74**	**71**	**73**	**71**	
2003-06-09	6 h 00 min	**61**	**55**	**76**	**77**	**74**	**76**	**74**	
2003-06-09	18 h 00 min	**69**	**65**	**79**	**81**	**77**	**80**	**79**	

B.3.4 Cross section D

Date	Time	Location in the building							
		1	2	3	4	5	6	7	etc.
2003-06-06	7 h 00 min	19	16						
2003-06-06	18 h 00 min	31	19						
2003-06-07	6 h 00 min	41	24						
2003-06-07	18 h 00 min	**51**	32						
2003-06-08	6 h 00 min	**55**	36						
2003-06-08	18 h 00 min	**62**	43						
2003-06-09	6 h 00 min	**67**	**50**						
2003-06-09	18 h 00 min	**73**	**60**						

B.3.5 Cross section E

Date	Time	Location in the building							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**etc.**
2003-06-06	7 h 00 min	19	16	19	19	19	13	16	
2003-06-06	18 h 00 min	26	23	**69**	**75**	**65**	**74**	**72**	
2003-06-07	6 h 00 min	34	31	**68**	**73**	**65**	**72**	**71**	
2003-06-07	18 h 00 min	45	40	**68**	**71**	**65**	**71**	**68**	
2003-06-08	6 h 00 min	**50**	44	**71**	**75**	**68**	**72**	**71**	
2003-06-08	18 h 00 min	**57**	**51**	**73**	**75**	**71**	**75**	**73**	
2003-06-09	6 h 00 min	**64**	**58**	**77**	**78**	**74**	**77**	**76**	
2003-06-09	18 h 00 min	**72**	**66**	**79**	**82**	**77**	**79**	**80**	

B.3.6 Data for the heating systems

Date	Time	Heater 1		Heater 2			
		Temperature (°C)	**Flow** (m^3/h)	**Temperature** (°C)	**Flow** (m^3/h)		
2003-06-06	8 h 00 min	81	6500	80	6000		
2003-06-07	18 h 00 min	81		78			
2003-06-08	6 h 00 min	77		74			
2003-06-08	18 h 00 min	78	6200	75	6100		
2003-06-09	6 h 00 min	78		76			
2003-06-09	18 h 00 min	78					

Signature ....
(Manager) (Foreman)

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