UIC CODE 624

3rd edition, February 2006

Translation

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Exhaust emission tests for diesel traction engines

Contrôle de l'émission des gaz d'échappement des moteurs diesel de traction
Abgasemissionsprüfung für Traktionsdieselmotoren

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Leaflet to be classified in Volume:

VI - Traction

Application:

With effect from 1 July 2005
All members of the International Union of Railways

Record of updates

1st edition, April 2002	First issue.
2nd edition, April 2003	Appendix G has been divided into G.1 and G.2, point 3.1 has been amended.
3rd edition, February 2006	Update of the exhaust emission limits, of the record of pollutants in exhaust gas and of the standard engines.

The person responsible for this leaflet is named in the UIC Code

Contents

Summary

This leaflet specifies limit values for exhaust gas emissions for diesel traction engines and describes the method used to determine them. It is applicable to engines to be built and used either on new tractive units or when re-engining existing tractive units.

1 - Scope

1.1 - The purpose of these international regulations is to define general limit values for the exhaust emissions of diesel traction engines and specify the method by which these emissions are to be determined.

1.2 - These regulations shall apply to diesel engines for railway traction, with the exception of engines for special locomotives (e.g. refinery or mine locomotives) and traction engines with an output of less than 100 kW.

1.3 - These regulations shall apply to all new engines used from the moment the leaflet is published in new vehicles or existing tractive units being re-engined.

2 - General

2.1 - The test method in question shall be used to check whether a given engine meets the exhaust emission limits laid down by UIC for diesel traction engines and whether it may therefore be used without restriction in new locomotives or for re-engining existing locomotives.

2.2 - Every engine to go through the exhaust emission test must be of standard design. The main engine components, in particular, must not differ from the standard design in any way that is liable to affect the technical value of the test.

2.3 - UIC is the official body mandated by engine manufacturers to carry out the tasks involved in organising and verifying the validity of tests and to approve the conformity of the product.

3 - Test conditions

3.1 - The exhaust emission test shall be conducted on the test rig of the engine manufacturer in accordance with *ISO standard 8178* (see Bibliography - page 19), using the F cycle and if need be cycle C1 also of part 4 of this standard. All the emission components indicated in Appendix A - page 10 shall be measured and the specific fuel consumption shall also be determined at each measurement point. The test shall be performed with a reference fuel as per *ISO standard 8178-5*.

3.2 - The test shall be conducted under the official supervision of the UIC or the managing RU if the body proposed by the engine manufacturer is not recognised by the UIC.

3.3 - The limit values applicable to exhaust gas emissions during the test on the rig are specified in Appendix A.

3.4 - The limit values to be observed shall be those in force at the time the contract for the purchase of the engine is signed.

3.5 - The engine shall be emission-tested at its nominal output/engine speed.

3.6 - If the same engine is used subsequently at a reduced nominal output or engine speed, no new test is required if the reduction in nominal output/engine speed does not exceed 10%.

3.7 - If a reduction of nominal output/engine speed results in the engine falling into a different power category, compliance with the limit values for the new power category must be verified.

4 - Request for an exhaust emission test

Any request for the execution of an exhaust emission test shall have the backing of at least one UIC member RU.

4.1 - The manufacturer shall first approach a UIC member RU from his own country, even if there are no immediate plans for the engine in question to be used on a vehicle/locomotive belonging to that RU.

If the national RU declines to back the request, the engine manufacturer shall contact other UIC member RUs in order to find an RU to support its application.

4.2 - This RU will then generally become the organising RU, assuming responsibility for the general organisation of the exhaust emission test. However, the general organisation may also be taken on by the UIC.

4.3 - The manufacturer shall send the organising RU and the UIC the following information:

- a description of the engine as specified in *UIC Leaflet 623-2, point 3* (see Bibliography - page 19);

- full details of the test rig used.

4.4 - The UIC shall check that all the required documents and technical details have been provided.

5 - Execution of the test

5.1 - Organisation of the test

5.1.1 - The time taken to organise the exhaust emission test, from the date the request is made to when the supervised measurements are carried out, shall not exceed 90 days.

5.1.2 - Before the test begins, the managing RU shall notify UIC of the request for an exhaust emission test and indicate the planned test programme.

5.1.3 - The UIC, in cooperation with the managing RU, shall hold discussions with the manufacturer to decide on the specific arrangements for the test and agree on which UIC language is to be used for drafting the test report.

5.1.4 - Work to be carried out on the rig and on the engine to be tested:

5.1.4.1 - The UIC shall ensure that the rig is compliant.

5.1.4.2 - The characteristic curves of the engine as referred to in *UIC Leaflet 623-2, point 3.4* shall be determined in the presence of a representative of the UIC or of a test engineer from the managing RU.

5.2 - Supervision of the test

5.2.1 - The representative of the UIC and, if necessary, the test engineer from the managing RU or his representative shall be present in order to supervise the exhaust gas measurements taken in accordance with *ISO standard 8178-4 Cycle F and/or C1* (see Bibliography - page 19).

5.2.2 - The manufacturer shall be solely responsible for running the test, the role of the UIC being essentially to authenticate the test proceedings and the results obtained.

5.2.3 - When the measurements are completed, a sample of the fuel used for the test shall be taken and sent to an independent laboratory recognised by the managing RU for analysis.

5.2.4 - Upon completion of this analysis, the test engineer provided by the managing RU and the UIC representative shall:

- compile the documents for the test report (see Appendix D - page 15),
- complete and sign the "conclusions" form (see Appendix E - page 16).

5.2.5 - A list of the parameters to be measured is given in Appendix C - page 13.

5.3 - Test report

5.3.1 - Within 45 days of completion of the exhaust emission test, the UIC - with the assistance of the test engineer from the managing RU and the manufacturer - shall draw up a test report based on the results obtained, in the UIC language previously chosen.

5.3.2 - After this test report has been translated into the other UIC languages, it shall be sent to:

- the manufacturer,
- the managing RU,
- and the UIC body responsible for the certification of diesel engines.

5.3.3 - The test report shall remain the property of the manufacturer and may not be released to third parties without its approval. UIC shall keep a copy of the test report for its records.

6 - Approval

6.1 - Tasks of the UIC

6.1.1 - The UIC shall send a copy of the test report to each member of the UIC body responsible for diesel engine certification and to each test engineer who supervised the tests.

6.1.2 - Within 30 days of receiving the report, the UIC body shall check that the measurements have been conducted properly and that the limit values have been complied with.

6.1.3 - Afterwards, UIC shall come to a decision on whether the emission values have been correctly determined and the limit values observed, and thereby whether approval can be granted. It shall inform:

- the manufacturer of the engine,
- the UIC,
- the managing RU

of its decision.

UIC shall also be responsible for updating the list of engines that have undergone an exhaust emissions test.

6.2 - List of engines tested

The diesel traction engines that have undergone an exhaust emissions test shall be listed in Appendix F - page 17.

7 - Costs of technical approval

All costs incurred as a result of the approval request shall generally be payable by the engine manufacturer, unless otherwise agreed.

These costs, which shall be covered by a contract between the manufacturer, the UIC and the managing RU respectively, shall relate in particular to:

- salaries,
- travel expenses,
- accommodation costs,
- cost of examination by the UIC technical body.

Appendix A - Exhaust emission limit values

The expression "locomotive" in the table below is to be understood for both switcher and main line locomotives.

Pollutant	Limit value applicable from 01.01.2003 [g/kWh] **UIC II**		Limit value applicable from 01.01.2006 [g/kWh] **UIC III A (railcars)**	Limit value applicable from 01.01.200 [g/kWh] **UIC III A (locomotives)**	Limit value applicable from 01.01.2009 [g/kWh] **UIC III A (locomotives)**	Limit value applicable from 01.01.2009 [g/kWh] **UIC III A (locomotives)**
	P ≤ 560 kW	**P > 560 kW**	**P > 130 kW**	**P > 130 kW P ≤ 560 kW**	**P ≤ 560 kW**	**P > 2 000 kW and cylinder capacity > 5 l/cylinder**
CO	2,5	3	3,5	3,5	3,5	3,5
NO_x	6	**n > 1 000 U/r.p.m. 9,5** **n ≤ 1 000 U/r.p.m. 9,9**	**NO_x + HC 4,0**	**NO_x + HC 4,0**	6,0	7,4
HC	0,6	0,8			0,5	0,4
PM	0,25	0,25	0,2	0,2	0,2	0,2
Test Cycle	F	F	C1	F	F	F

The engines have to comply with the requirements of the *European Directive 2004/26/CE*, as well as with eventual national requirements, like the dates of reception and the start of service.

Appendix B - Record of pollutants measured in exhaust gas

The test below was conducted in the following test conditions:

Engine builder:		Atmospheric pressure:	kPa
Engine number:		Ambient air temperature Ta:	°C
Nominal power (kW):		Relative humidity:	%
Nominal speed (U/r.p.m.):		Water content of the air:	g/kg
Minimum no-load speed (U/r.p.m.):		Height of test site above normal zero:	m
		Cooling water temperature at engine inlet:	°C
		Air temperature at the cylinder head inlet during pollution tests at nominal power:	°C

Mode as per *ISO 8178-4*	Output	Speed	Inlet pressure	Intake air		Fuel	CO		NO_x			HC (total)		PM (total)
	P(kW)	n(l/min)	(kPa)	(m^3/h)	(kg/h)	(kg/h)	(ppm)	(g/h)	(ppm)	(g/h)	corrected as per ISO 8178	(ppm)	(g/h)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Calculated specific emission values

Mode as per *ISO 8178-4*	Output P(kW)	Speed n(l/min)	Air-through-put kg/h	Fuel consump-tion kg/h	Weight-ing factor WF	Weighted output P WF (kW)	CO Weighted CO.WF emission value (g/h)	NO_x Weighted NO_x.WF emission value (g/h)	HC Weighted HC.WF emission value (g/h)	PM Weighted PM.WF emission value (g/h)
1					0,25					
2					0,15					
3					0,6					
						ΣP WF	ΣCO.WF	ΣNO_x.WF	ΣHC.WF	ΣPM.WF
							$\frac{\Sigma CO.WF}{\Sigma P.WF}$ (g/kWh)	$\frac{\Sigma NO_x.WF}{\Sigma P.WF}$ (g/kWh)	$\frac{\Sigma HC.WF}{\Sigma P.WF}$ (g/kWh)	$\frac{\Sigma PM.WF}{\Sigma P.WF}$ (g/kWh)
						measured values				
						limit values				
Smoke								measured values		
								limit values [a]		

a. This limit applies to air thoughput at nominal power.

Test date:

Company: RU:

Signature: Signature:

Recognised body:

Signature:

Appendix C - Measured and calculated values

Manufacturer of the test rig: Type:

Computer supplier: Type:

Designation	No. of measuring point [a]	Sensors		Channels			Output		Observations [e]
		Type	Acc. [b]	No.	Characteristics	Freq [c]	Screen [d]	Printer	
1) Water:					(mV/°C)				
Temperature	22 23 etc.								
Throughput	18 19								
Pressure	15 20 21								
2) Oil:									
Temperature	16 17								
Throughput									
Pressure	14								
3) Air:									
Temperature	42 47 48								
Throughput / Hygrometry	43								
Pressure	41 44 45 46								
4) Gas:									
Temperature	28 29 30 etc.								
Throughput									
Pressure	37 38 39								
5) Fuel:									Min. calor. value [f]
Temperature									
Consumption per unit of time	10								
6) Mechanical parameters:									
rpm of engine	5								
Engine torque	40								

Designation	No. of measuring point [a]	Sensors		Channels			Output		Observations [e]
		Type	Acc. [b]	No.	Characteristics	Freq [c]	Screen [d]	Printer	
7) <u>Calculated values</u>: Mechanical engine power Mechanical engine output Specific consumption	Mathematical expression: [g]								

a. The reference number used to identify the measuring devices. Use the reference numbers shown on the manufacturer's drawing.
b. Acc: degree of accuracy according to ISO 3046-3.
c. Freq indicates the scanning frequency of the different channels and the updating frequency of the calculated values when these appear on the screen.
d. Output shows whether a value is displayed on the screen and/or printed by the printer.
e. Indicate "manual data logging" against the values entered at the computer keyboard.
f. Indicate the minimum calorific value of the fuel actually used.
g. Indicate the minimum calorific value adjusted according to UIC Leaflet 623-2, point 3.4.

Appendix D - List of principal documents to be provided with the test report

The documents to be incorporated in the test report are indicated in *ISO standard 8178-6* (see Bibliography - page 19). The report must also contain the following documents:

"Conclusions" form	*UIC Leaflet 624*, Appendix E - page 16
Summary	
Documents to be submitted	*UIC Leaflet 623-1, point 4.1.4*
Running of the test	*UIC Leaflet 624,* point 4 - page 5
Results: - Output and torque curves - Fuel consumption curves	*UIC Leaflet 624,* point 5.1.4.2 - page 6 and Appendix C - page 13
- Pollutant emissions: • CO • NO_x • HC • PM • BOSCH index	*UIC Leaflet 624*, Appendix B - page 11

Appendix E - Conclusions of the test engineers concerning the exhaust emissions test on the diesel engine

"*name of firm*"

"*type of engine*"

with "*number*" **cylinders**

with a nominal rating of "....." kW

with an engine speed of "....." U/r.p.m.

"....." stroke

TEST SCHEDULE:

The following exhaust emission values were determined on ..... "*date*":

Pollutant emissions:

Pollutants	Permissible limit values as per UIC... (g/kWh)	Specific emissions measured as per Cycle F (g/kWh)	Specific emissions measured as per Cycle C1 (g/kWh)
CO			
NO_x			
HC			
Particulate			

Expert approval:

All the measurements taken during the exhaust emissions test together with miscellaneous information (characteristic curves, fuel analysis, etc.) are provided in appendix to the test report.

PROPOSAL OF THE TEST ENGINEERS
"Recommended / Not Recommended for Approval"

"Place", "Date"

For "*RU*"
"signature"
"Typed *Name*"

For "*UIC*"
"signature"
"Typed name"

Appendix F - Engines complying with UIC II exhaust emissions limit values and which are approved for use as of 01.01.2003 both on new vehicles to be built and on existing vehicles being re-engined

The list of approved engines can be found on the UIC Website: http://www.uic.asso.fr / Technical and Research/ Products/ Catalogue of products technically approved by UIC.

Glossary

Bosch Index	Blackening recorded by a "Bosch"-type measuring instrument, corresponding to the soot in exhaust gas
UIC I	Pollutant limits in force until 31/12/2002
UIC II	Pollutant limits in force as of 01/01/2003
UIC III	Pollutant limits in force from 01/01/2006 to 01/01/2009

Bibliography

1. UIC leaflets

International Union of Railways
UIC Leaflet 623-1: Approval procedures for diesel engines of motive power units, 3rd edition, April 2005

UIC Leaflet 623-2: Approval tests for diesel engines of motive power units, 3rd edition, April 2005

2. European standards

European Union
Directive 2004/26/EC of the European Parliament and of the Council of 21 April 2004 amending Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery, Official Journal L 146, 30/04/2004 P. 0001 - 0110

3. International standards

International Organization for Standardization (ISO)
ISO 3046-3: 1989 : Reciprocating internal combustion engines - Performance - Part 3: Test measurements, 1989

ISO 8178-4:1996 : Reciprocating internal combustion engines - Exhaust emission measurement - Part 4: Test cycles for different engine applications, 1996

ISO 8178-5:1997 : Reciprocating internal combustion engines - Exhaust emission measurement - Part 5: Test fuels, 1997

ISO 8178-6:2000 : Reciprocating internal combustion engines - Exhaust emission measurement - Part 6: Report of measuring results and tests, 2000

Warning

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