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(Acts whose publication is obligatory)

DIRECTIVE 2002/87/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 16 December 2002

on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate and amending Council Directives 73/239/EEC, 79/267/EEC, 92/49/EEC, 92/96/EEC, 93/6/EEC and 93/22/EEC, and Directives 98/78/EC and 2000/12/EC of the European Parliament and of the Council

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 47(2) thereof,

Having regard to the proposal from the Commission ⁽¹⁾,

Having regard to the opinion of the Economic and Social Committee ⁽²⁾,

After consulting the Committee of the Regions,

Having regard to the opinion of the European Central Bank ⁽³⁾,

Acting in accordance with the procedure laid down in Article 251 of the Treaty ⁽⁴⁾,

Whereas:

- (1) The current Community legislation provides for a comprehensive set of rules on the prudential supervision of credit institutions, insurance undertakings and investment firms on a stand alone basis and credit institutions, insurance undertakings and investment firms which are part of respectively a banking/investment firm group or an insurance group, i.e. groups with homogeneous financial activities.
- (2) New developments in financial markets have led to the creation of financial groups which provide services and products in different sectors of the financial markets,

⁽¹⁾ OJ C 213 E, 31.7.2001, p. 227.

⁽²⁾ OJ C 36, 8.2.2002, p. 1.

⁽³⁾ OJ C 271, 26.9.2001, p. 10.

⁽⁴⁾ Opinion of the European Parliament of 14 March 2002 (not yet published in the Official Journal), Council Common Position of 12 September 2002 (OJ C 253 E, 22.10.2002, p. 1) and Decision of the European Parliament of 20 November 2002 (not yet published in the Official Journal).

called financial conglomerates. Until now, there has been no form of prudential supervision on a group-wide basis of credit institutions, insurance undertakings and investment firms which are part of such a conglomerate, in particular as regards the solvency position and risk concentration at the level of the conglomerate, the intra-group transactions, the internal risk management processes at conglomerate level, and the fit and proper character of the management. Some of these conglomerates are among the biggest financial groups which are active in the financial markets and provide services on a global basis. If such conglomerates, and in particular credit institutions, insurance undertakings and investment firms which are part of such a conglomerate, were to face financial difficulties, these could seriously destabilise the financial system and affect individual depositors, insurance policy holders and investors.

- (3) The Commission Action Plan for Financial Services identifies a series of actions which are needed to complete the Single Market in Financial Services, and announces the development of supplementary prudential legislation for financial conglomerates which will address loopholes in the present sectoral legislation and additional prudential risks to ensure sound supervisory arrangements with regard to financial groups with cross-sectoral financial activities. Such an ambitious objective can only be attained in stages. The establishment of the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate is one such stage.
- (4) Other international forums have also identified the need for the development of appropriate supervisory concepts with regard to financial conglomerates.
- (5) In order to be effective, the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate should be applied to all such conglomerates, the cross-sectoral financial activities of which are significant, which is the case when certain thresholds are reached, no matter how they are structured. Supplementary supervision should cover all financial activities identified by the sectoral financial legislation and all entities principally

- engaged in such activities should be included in the scope of the supplementary supervision, including asset management companies.
- (6) Decisions not to include a particular entity in the scope of supplementary supervision should be taken, bearing in mind *inter alia* whether or not such entity is included in the group-wide supervision under sectoral rules.
- (7) The competent authorities should be able to assess at a group-wide level the financial situation of credit institutions, insurance undertakings and investment firms which are part of a financial conglomerate, in particular as regards solvency (including the elimination of multiple gearing of own funds instruments), risk concentration and intra-group transactions.
- (8) Financial conglomerates are often managed on a business-line basis which does not fully coincide with the conglomerate's legal structures. In order to take account of this trend, the requirements for management should be further extended, in particular as regards the management of the mixed financial holding company.
- (9) All financial conglomerates subject to supplementary supervision should have a coordinator appointed from among the competent authorities involved.
- (10) The tasks of the coordinator should not affect the tasks and responsibilities of the competent authorities as provided for by the sectoral rules.
- (11) The competent authorities involved, and especially the coordinator, should have the means of obtaining from the entities within a financial conglomerate, or from other competent authorities, the information necessary for the performance of their supplementary supervision.
- (12) There is a pressing need for increased collaboration between authorities responsible for the supervision of credit institutions, insurance undertakings and investment firms, including the development of ad hoc cooperation arrangements between the authorities involved in the supervision of entities belonging to the same financial conglomerate.
- (13) Credit institutions, insurance undertakings and investment firms which have their head office in the Community can be part of a financial conglomerate, the head of which is outside the Community. These regulated entities should also be subject to equivalent and appropriate supplementary supervisory arrangements which achieve objectives and results similar to those pursued by the provisions of this Directive. To this end, transparency of rules and exchange of information with third-country authorities on all relevant circumstances are of great importance.
- (14) Equivalent and appropriate supplementary supervisory arrangements can only be assumed to exist if the third-country supervisory authorities have agreed to cooperate with the competent authorities concerned on the means and objectives of exercising supplementary supervision of the regulated entities of a financial conglomerate.
- (15) This Directive does not require the disclosure by competent authorities to a financial conglomerates committee of information which is subject to an obligation of confidentiality under this Directive or other sectoral directives.
- (16) Since the objective of the proposed action, namely the establishment of rules on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate, cannot be sufficiently achieved by the Member States and can therefore, by reason of the scale and the effects of the action, be better achieved at Community level, the Community may adopt measures, in accordance with the principle of subsidiarity as set out in Article 5 of the Treaty. In accordance with the principle of proportionality, as set out in that Article, this Directive does not go beyond what is necessary in order to achieve this objective. Since this Directive defines minimum standards, Member States may lay down stricter rules.
- (17) This Directive respects the fundamental rights and observes the principles recognised in particular by the Charter of Fundamental Rights of the European Union.
- (18) The measures necessary for the implementation of this Directive should be adopted in accordance with Council Decision 1999/468/EC of 28 June 1999 laying down the procedures for the exercise of implementing powers conferred on the Commission ⁽¹⁾.
- (19) Technical guidance and implementing measures for the rules laid down in this Directive may from time to time be necessary to take account of new developments on financial markets. The Commission should accordingly be empowered to adopt implementing measures, provided that these do not modify the essential elements of this Directive.

(1) OJ L 184, 17.7.1999, p. 23.

- (20) The existing sectoral rules for credit institutions, insurance undertakings and investment firms should be supplemented to a minimum level, in particular to avoid regulatory arbitrage between the sectoral rules and those for financial conglomerates. Therefore, First Council Directive 73/239/EEC of 24 July 1973 on the coordination of laws, regulations and administrative provisions relating to the taking up and pursuit of the business of direct insurance other than life assurance ⁽¹⁾, First Council Directive 79/267/EEC of 5 March 1979 on the coordination of laws, regulations and administrative provisions relating to the taking up and pursuit of the business of direct life assurance ⁽²⁾, Council Directive 92/49/EEC of 18 June 1992 on the coordination of laws, regulations and administrative provisions relating to direct insurance other than life insurance (third non-life insurance Directive) ⁽³⁾, Council Directive 92/96/EEC of 10 November 1992 on the coordination of laws, regulations and administrative provisions relating to direct life assurance (third life insurance Directive) ⁽⁴⁾, Council Directive 93/6/EEC of 15 March 1993 on the capital adequacy of investments firms and credit institutions ⁽⁵⁾ and Council Directive 93/22/EEC of 10 May 1993 on investment services in the securities field ⁽⁶⁾, as well as Directive 98/78/EC of the European Parliament and of the Council of 27 October 1998 on the supplementary supervision of insurance undertakings in an insurance group ⁽⁷⁾ and Directive 2000/12/EC of the European Parliament and of the Council of 20 March 2000 relating to the taking up and pursuit of the business of credit institutions ⁽⁸⁾ should be amended accordingly. The objective of further harmonisation can, however, only be achieved by stages and needs to be based on careful analysis.
- (21) In order to assess the need for and prepare any possible future harmonisation of the treatment of asset management companies under sectoral rules, the Commission should report on Member States' practices in this field,

HAVE ADOPTED THIS DIRECTIVE:

CHAPTER I

OBJECTIVE AND DEFINITIONS

Article 1

Objective

This Directive lays down rules for supplementary supervision of regulated entities which have obtained an authorisation pursuant to Article 6 of Directive 73/239/EEC, Article 6 of Directive 79/267/EEC, Article 3(1) of Directive 93/22/EEC or Article 4 of Directive 2000/12/EC, and which are part of a financial conglomerate. It also amends the relevant sectoral rules which apply to entities regulated by the Directives referred to above.

Article 2

Definitions

For the purposes of this Directive:

- 'credit institution' shall mean a credit institution within the meaning of the second subparagraph of Article 1(1) of Directive 2000/12/EC;
- 'insurance undertaking' shall mean an insurance undertaking within the meaning of Article 6 of Directive 73/239/EEC, Article 6 of Directive 79/267/EEC or Article 1(b) of Directive 98/78/EC;
- 'investment firm' shall mean an investment firm within the meaning of Article 1(2) of Directive 93/22/EEC, including the undertakings referred to in Article 2(4) of Directive 93/6/EEC;
- 'regulated entity' shall mean a credit institution, an insurance undertaking or an investment firm;
- 'asset management company' shall mean a management company within the meaning of Article 1a(2) of Council Directive 85/611/EEC of 20 December 1985 on the coordination of laws, regulations and administrative provisions relating to undertakings for collective investment in transferable securities (UCITS) ⁽⁹⁾, as well as an undertaking the registered office of which is outside the Community and which would require authorisation in accordance with Article 5(1) of that Directive if it had its registered office within the Community;
- 'reinsurance undertaking' shall mean a reinsurance undertaking within the meaning of Article 1(c) of Directive 98/78/EC;

⁽¹⁾ OJ L 228, 16.8.1973, p. 3. Directive as last amended by Directive 2002/13/EC of the European Parliament and of the Council (OJ L 77, 20.3.2002, p. 17).

⁽²⁾ OJ L 63, 13.3.1979, p. 1. Directive as last amended by Directive 2002/12/EC of the European Parliament and of the Council (OJ L 77, 20.3.2002, p. 11).

⁽³⁾ OJ L 228, 11.8.1992, p. 1. Directive as last amended by Directive 2000/64/EC of the European Parliament and of the Council (OJ L 290, 17.11.2000, p. 27).

⁽⁴⁾ OJ L 360, 9.12.1992, p. 1. Directive as last amended by Directive 2000/64/EC.

⁽⁵⁾ OJ L 141, 11.6.1993, p. 1. Directive as last amended by Directive 98/33/EC of the European Parliament and of the Council (OJ L 204, 21.7.1998, p. 29).

⁽⁶⁾ OJ L 141, 11.6.1993, p. 27. Directive as last amended by Directive 2000/64/EC.

⁽⁷⁾ OJ L 330, 5.12.1998, p. 1.

⁽⁸⁾ OJ L 126, 26.5.2000, p. 1. Directive as amended by Directive 2000/28/EC (OJ L 275, 27.10.2000, p. 37).

⁽⁹⁾ OJ L 375, 31.12.1985, p. 3. Directive as last amended by Directive 2001/108/EC of the European Parliament and of the Council (OJ L 41, 13.2.2002, p. 35).

7. 'sectoral rules' shall mean the Community legislation relating to the prudential supervision of regulated entities, in particular laid down in Directives 73/239/EEC, 79/267/EEC, 98/78/EC, 93/6/EEC, 93/22/EEC and 2000/12/EC;
8. 'financial sector' shall mean a sector composed of one or more of the following entities:
- (a) a credit institution, a financial institution or an ancillary banking services undertaking within the meaning of Article 1(5) and (23) of Directive 2000/12/EC (the banking sector);
 - (b) an insurance undertaking, a reinsurance undertaking or an insurance holding company within the meaning of Article 1(i) of Directive 98/78/EC (the insurance sector);
 - (c) an investment firm or a financial institution within the meaning of Article 2(7) of Directive 93/6/EEC (the investment services sector);
 - (d) a mixed financial holding company;
9. 'parent undertaking' shall mean a parent undertaking within the meaning of Article 1 of Seventh Council Directive 83/349/EEC of 13 June 1983 on consolidated accounts ⁽¹⁾ and any undertaking which, in the opinion of the competent authorities, effectively exercises a dominant influence over another undertaking;
10. 'subsidiary undertaking' shall mean a subsidiary undertaking within the meaning of Article 1 of Directive 83/349/EEC and any undertaking over which, in the opinion of the competent authorities, a parent undertaking effectively exercises a dominant influence; all subsidiary undertakings of subsidiary undertakings shall also be considered as subsidiary undertakings of the parent undertaking;
11. 'participation' shall mean a participation within the meaning of the first sentence of Article 17 of Fourth Council Directive 78/660/EEC of 25 July 1978 on the annual accounts of certain types of companies ⁽²⁾, or the direct or indirect ownership of 20 % or more of the voting rights or capital of an undertaking;
12. 'group' shall mean a group of undertakings, which consists of a parent undertaking, its subsidiaries and the entities in which the parent undertaking or its subsidiaries hold a participation, as well as undertakings linked to each other by a relationship within the meaning of Article 12(1) of Directive 83/349/EEC;
13. 'close links' shall mean a situation in which two or more natural or legal persons are linked by:
- (a) 'participation', which shall mean the ownership, direct or by way of control, of 20 % or more of the voting rights or capital of an undertaking; or
 - (b) 'control', which shall mean the relationship between a parent undertaking and a subsidiary, in all the cases referred to in Article 1(1) and (2) of Directive 83/349/EEC, or a similar relationship between any natural or legal person and an undertaking; any subsidiary undertaking of a subsidiary undertaking shall also be considered a subsidiary of the parent undertaking which is at the head of those undertakings.
- A situation in which two or more natural or legal persons are permanently linked to one and the same person by a control relationship shall also be regarded as constituting a close link between such persons;
14. 'financial conglomerate' shall mean a group which meets, subject to Article 3, the following conditions:
- (a) a regulated entity within the meaning of Article 1 is at the head of the group or at least one of the subsidiaries in the group is a regulated entity within the meaning of Article 1;
 - (b) where there is a regulated entity within the meaning of Article 1 at the head of the group, it is either a parent undertaking of an entity in the financial sector, an entity which holds a participation in an entity in the financial sector, or an entity linked with an entity in the financial sector by a relationship within the meaning of Article 12(1) of Directive 83/349/EEC;
 - (c) where there is no regulated entity within the meaning of Article 1 at the head of the group, the group's activities mainly occur in the financial sector within the meaning of Article 3(1);
 - (d) at least one of the entities in the group is within the insurance sector and at least one is within the banking or investment services sector;
 - (e) the consolidated and/or aggregated activities of the entities in the group within the insurance sector and the consolidated and/or aggregated activities of the entities within the banking and investment services sector are both significant within the meaning of Article 3(2) or (3).

⁽¹⁾ OJ L 193, 18.7.1983, p. 1. Directive as last amended by Directive 2001/65/EC of the European Parliament and of the Council (OJ L 283, 27.10.2001, p. 28).

⁽²⁾ OJ L 222, 14.8.1978, p. 11. Directive as last amended by Directive 2001/65/EC.

Any subgroup of a group within the meaning of point 12 which meets the criteria in this point shall be considered as a financial conglomerate;

15. 'mixed financial holding company' shall mean a parent undertaking, other than a regulated entity, which together with its subsidiaries, at least one of which is a regulated entity which has its head office in the Community, and other entities, constitutes a financial conglomerate;
16. 'competent authorities' shall mean the national authorities of the Member States which are empowered by law or regulation to supervise credit institutions, and/or insurance undertakings and/or investment firms whether on an individual or a group-wide basis;
17. 'relevant competent authorities' shall mean:
- Member States' competent authorities responsible for the sectoral group-wide supervision of any of the regulated entities in a financial conglomerate;
 - the coordinator appointed in accordance with Article 10 if different from the authorities referred to in (a);
 - other competent authorities concerned, where relevant, in the opinion of the authorities referred to in (a) and (b); this opinion shall especially take into account the market share of the regulated entities of the conglomerate in other Member States, in particular if it exceeds 5 %, and the importance in the conglomerate of any regulated entity established in another Member State;
18. 'intra-group transactions' shall mean all transactions by which regulated entities within a financial conglomerate rely either directly or indirectly upon other undertakings within the same group or upon any natural or legal person linked to the undertakings within that group by 'close links', for the fulfilment of an obligation, whether or not contractual, and whether or not for payment;
19. 'risk concentration' shall mean all exposures with a loss potential borne by entities within a financial conglomerate, which are large enough to threaten the solvency or the financial position in general of the regulated entities in the financial conglomerate; such exposures may be caused by counterparty risk/credit risk, investment risk, insurance risk, market risk, other risks, or a combination or interaction of these risks.

Article 3

Thresholds for identifying a financial conglomerate

1. For the purposes of determining whether the activities of a group mainly occur in the financial sector, within the meaning of Article 2(14)(c), the ratio of the balance sheet total of the regulated and non-regulated financial sector entities in the group to the balance sheet total of the group as a whole should exceed 40 %.

2. For the purposes of determining whether activities in different financial sectors are significant within the meaning of Article 2(14)(e), for each financial sector the average of the ratio of the balance sheet total of that financial sector to the balance sheet total of the financial sector entities in the group and the ratio of the solvency requirements of the same financial sector to the total solvency requirements of the financial sector entities in the group should exceed 10 %.

For the purposes of this Directive, the smallest financial sector in a financial conglomerate is the sector with the smallest average and the most important financial sector in a financial conglomerate is the sector with the highest average. For the purposes of calculating the average and for the measurement of the smallest and the most important financial sectors, the banking sector and the investment services sector shall be considered together.

3. Cross-sectoral activities shall also be presumed to be significant within the meaning of Article 2(14)(e) if the balance sheet total of the smallest financial sector in the group exceeds EUR 6 billion. If the group does not reach the threshold referred to in paragraph 2, the relevant competent authorities may decide by common agreement not to regard the group as a financial conglomerate, or not to apply the provisions of Articles 7, 8 or 9, if they are of the opinion that the inclusion of the group in the scope of this Directive or the application of such provisions is not necessary or would be inappropriate or misleading with respect to the objectives of supplementary supervision, taking into account, for instance, the fact that:

- the relative size of its smallest financial sector does not exceed 5 %, measured either in terms of the average referred to in paragraph 2 or in terms of the balance sheet total or the solvency requirements of such financial sector; or
- the market share does not exceed 5 % in any Member State, measured in terms of the balance sheet total in the banking or investment services sectors and in terms of gross premiums written in the insurance sector.

Decisions taken in accordance with this paragraph shall be notified to the other competent authorities concerned.

4. For the application of paragraphs 1, 2 and 3, the relevant competent authorities may by common agreement:

- exclude an entity when calculating the ratios, in the cases referred to in Article 6(5);
- take into account compliance with the thresholds envisaged in paragraphs 1 and 2 for three consecutive years so as to avoid sudden regime shifts, and disregard such compliance if there are significant changes in the group's structure.

Where a financial conglomerate has been identified according to paragraphs 1, 2 and 3, the decisions referred to in the first subparagraph of this paragraph shall be taken on the basis of a proposal made by the coordinator of that financial conglomerate.

5. For the application of paragraphs 1 and 2, the relevant competent authorities may, in exceptional cases and by common agreement, replace the criterion based on balance sheet total with one or both of the following parameters or add one or both of these parameters, if they are of the opinion that these parameters are of particular relevance for the purposes of supplementary supervision under this Directive: income structure, off-balance-sheet activities.

6. For the application of paragraphs 1 and 2, if the ratios referred to in those paragraphs fall below 40 % and 10 % respectively for conglomerates already subject to supplementary supervision, a lower ratio of 35 % and 8 % respectively shall apply for the following three years to avoid sudden regime shifts.

Similarly, for the application of paragraph 3, if the balance sheet total of the smallest financial sector in the group falls below EUR 6 billion for conglomerates already subject to supplementary supervision, a lower figure of EUR 5 billion shall apply for the following three years to avoid sudden regime shifts.

During the period referred to in this paragraph, the coordinator may, with the agreement of the other relevant competent authorities, decide that the lower ratios or the lower amount referred to in this paragraph shall cease to apply.

7. The calculations referred to in this Article regarding the balance sheet shall be made on the basis of the aggregated balance sheet total of the entities of the group, according to their annual accounts. For the purposes of this calculation, undertakings in which a participation is held shall be taken into account as regards the amount of their balance sheet total corresponding to the aggregated proportional share held by the group. However, where consolidated accounts are available, they shall be used instead of aggregated accounts.

The solvency requirements referred to in paragraphs 2 and 3 shall be calculated in accordance with the provisions of the relevant sectoral rules.

Article 4

Identifying a financial conglomerate

1. Competent authorities which have authorised regulated entities shall, on the basis of Articles 2, 3 and 5, identify any group that falls under the scope of this Directive.

For this purpose:

- competent authorities which have authorised regulated entities in the group shall, where necessary, cooperate closely,

- if a competent authority is of the opinion that a regulated entity authorised by that competent authority is a member of a group which may be a financial conglomerate, which has not already been identified according to this Directive, the competent authority shall communicate its view to the other competent authorities concerned.

2. The coordinator appointed in accordance with Article 10 shall inform the parent undertaking at the head of a group or, in the absence of a parent undertaking, the regulated entity with the largest balance sheet total in the most important financial sector in a group, that the group has been identified as a financial conglomerate and of the appointment of the coordinator. The coordinator shall also inform the competent authorities which have authorised regulated entities in the group and the competent authorities of the Member State in which the mixed financial holding company has its head office, as well as the Commission.

CHAPTER II

SUPPLEMENTARY SUPERVISION

SECTION 1

SCOPE

Article 5

Scope of supplementary supervision of regulated entities referred to in Article 1

1. Without prejudice to the provisions on supervision contained in the sectoral rules, Member States shall provide for the supplementary supervision of the regulated entities referred to in Article 1, to the extent and in the manner prescribed in this Directive.

2. The following regulated entities shall be subject to supplementary supervision at the level of the financial conglomerate in accordance with Articles 6 to 17:

- (a) every regulated entity which is at the head of a financial conglomerate;
- (b) every regulated entity, the parent undertaking of which is a mixed financial holding company which has its head office in the Community;
- (c) every regulated entity linked with another financial sector entity by a relationship within the meaning of Article 12(1) of Directive 83/349/EEC.

Where a financial conglomerate is a subgroup of another financial conglomerate which meets the requirements of the first subparagraph, Member States may apply Articles 6 to 17 to the regulated entities within the latter group only and any reference in the Directive to the terms group and financial conglomerate will then be understood as referring to that latter group.

3. Every regulated entity which is not subject to supplementary supervision in accordance with paragraph 2, the parent undertaking of which is a regulated entity or a mixed financial holding company, having its head office outside the Community, shall be subject to supplementary supervision at the level of the financial conglomerate to the extent and in the manner prescribed in Article 18.

4. Where persons hold participations or capital ties in one or more regulated entities or exercise significant influence over such entities without holding a participation or capital ties, other than the cases referred to in paragraphs 2 and 3, the relevant competent authorities shall, by common agreement and in conformity with national law, determine whether and to what extent supplementary supervision of the regulated entities is to be carried out, as if they constitute a financial conglomerate.

In order to apply such supplementary supervision, at least one of the entities must be a regulated entity as referred to in Article 1 and the conditions set out in Article 2(14)(d) and (e) must be met. The relevant competent authorities shall take their decision, taking into account the objectives of the supplementary supervision as provided for by this Directive.

For the purposes of applying the first subparagraph to 'cooperative groups', the competent authorities must take into account the public financial commitment of these groups with respect to other financial entities.

5. Without prejudice to Article 13, the exercise of supplementary supervision at the level of the financial conglomerate shall in no way imply that the competent authorities are required to play a supervisory role in relation to mixed financial holding companies, third-country regulated entities in a financial conglomerate or unregulated entities in a financial conglomerate, on a stand-alone basis.

SECTION 2

FINANCIAL POSITION

Article 6

Capital adequacy

1. Without prejudice to the sectoral rules, supplementary supervision of the capital adequacy of the regulated entities in a financial conglomerate shall be exercised in accordance with the rules laid down in Article 9(2) to (5), in Section 3 of this Chapter, and in Annex I.

2. The Member States shall require regulated entities in a financial conglomerate to ensure that own funds are available at the level of the financial conglomerate which are always at least equal to the capital adequacy requirements as calculated in accordance with Annex I.

The Member States shall also require regulated entities to have in place adequate capital adequacy policies at the level of the financial conglomerate.

The requirements referred to in the first and second subparagraphs shall be subject to supervisory overview by the coordinator in accordance with Section 3.

The coordinator shall ensure that the calculation referred to in the first subparagraph is carried out at least once a year, either by the regulated entities or by the mixed financial holding company.

The results of the calculation and the relevant data for the calculation shall be submitted to the coordinator by the regulated entity within the meaning of Article 1 which is at the head of the financial conglomerate, or, where the financial conglomerate is not headed by a regulated entity within the meaning of Article 1, by the mixed financial holding company or by the regulated entity in the financial conglomerate identified by the coordinator after consultation with the other relevant competent authorities and with the financial conglomerate.

3. For the purposes of calculating the capital adequacy requirements referred to in the first subparagraph of paragraph 2, the following entities shall be included in the scope of supplementary supervision in the manner and to the extent defined in Annex I:

- (a) a credit institution, a financial institution or an ancillary banking services undertaking within the meaning of Article 1(5) and (23) of Directive 2000/12/EC;
- (b) an insurance undertaking, a reinsurance undertaking or an insurance holding company within the meaning of Article 1(i) of Directive 98/78/EC;
- (c) an investment firm or a financial institution within the meaning of Article 2(7) of Directive 93/6/EEC;
- (d) mixed financial holding companies.

4. When calculating the supplementary capital adequacy requirements with regard to a financial conglomerate by applying method 1 (Accounting consolidation) referred to in Annex I, the own funds and the solvency requirements of the entities in the group shall be calculated by applying the corresponding sectoral rules on the form and extent of consolidation as laid down in particular in Article 54 of Directive 2000/12/EC and Annex I.1.B. of Directive 98/78/EC.

When applying methods 2 or 3 (Deduction and aggregation, Book value/Requirement deduction) referred to in Annex I, the calculation shall take account of the proportional share held by the parent undertaking or undertaking which holds a participation in another entity of the group. 'Proportional share' means the proportion of the subscribed capital which is held, directly or indirectly, by that undertaking.

5. The coordinator may decide not to include a particular entity in the scope when calculating the supplementary capital adequacy requirements in the following cases:

- (a) if the entity is situated in a third country where there are legal impediments to the transfer of the necessary information, without prejudice to the sectoral rules regarding the obligation of competent authorities to refuse authorisation where the effective exercise of their supervisory functions is prevented;
- (b) if the entity is of negligible interest with respect to the objectives of the supplementary supervision of regulated entities in a financial conglomerate;
- (c) if the inclusion of the entity would be inappropriate or misleading with respect to the objectives of supplementary supervision.

However, if several entities are to be excluded pursuant to (b) of the first subparagraph, they must nevertheless be included when collectively they are of non-negligible interest.

In the case mentioned in (c) of the first subparagraph the coordinator shall, except in cases of urgency, consult the other relevant competent authorities before taking a decision.

When the coordinator does not include a regulated entity in the scope under one of the cases provided for in (b) and (c) of the first subparagraph, the competent authorities of the Member State in which that entity is situated may ask the entity which is at the head of the financial conglomerate for information which may facilitate their supervision of the regulated entity.

Article 7

Risk concentration

1. Without prejudice to the sectoral rules, supplementary supervision of the risk concentration of regulated entities in a financial conglomerate shall be exercised in accordance with the rules laid down in Article 9(2) to (4), in Section 3 of this Chapter and in Annex II.

2. The Member States shall require regulated entities or mixed financial holding companies to report on a regular basis and at least annually to the coordinator any significant risk concentration at the level of the financial conglomerate, in accordance with the rules laid down in this Article and in Annex II. The necessary information shall be submitted to the coordinator by the regulated entity within the meaning of Article 1 which is at the head of the financial conglomerate or, where the financial conglomerate is not headed by a regulated entity within the meaning of Article 1, by the mixed financial holding company or by the regulated entity in the financial conglomerate identified by the coordinator after consultation with the other relevant competent authorities and with the financial conglomerate.

These risk concentrations shall be subject to supervisory overview by the coordinator in accordance with Section 3.

3. Pending further coordination of Community legislation, Member States may set quantitative limits or allow their competent authorities to set quantitative limits, or take other supervisory measures which would achieve the objectives of supplementary supervision, with regard to any risk concentration at the level of a financial conglomerate.

4. Where a financial conglomerate is headed by a mixed financial holding company, the sectoral rules regarding risk concentration of the most important financial sector in the financial conglomerate, if any, shall apply to that sector as a whole, including the mixed financial holding company.

Article 8

Intra-group transactions

1. Without prejudice to the sectoral rules, supplementary supervision of intra-group transactions of regulated entities in a financial conglomerate shall be exercised in accordance with the rules laid down in Article 9(2) to (4), in Section 3 of this Chapter, and in Annex II.

2. The Member States shall require regulated entities or mixed financial holding companies to report, on a regular basis and at least annually, to the coordinator all significant intra-group transactions of regulated entities within a financial conglomerate, in accordance with the rules laid down in this Article and in Annex II. Insofar as no definition of the thresholds referred to in the last sentence of the first paragraph of Annex II has been drawn up, an intra-group transaction shall be presumed to be significant if its amount exceeds at least 5 % of the total amount of capital adequacy requirements at the level of a financial conglomerate.

The necessary information shall be submitted to the coordinator by the regulated entity within the meaning of Article 1 which is at the head of the financial conglomerate or, where the financial conglomerate is not headed by a regulated entity within the meaning of Article 1, by the mixed financial holding company or by the regulated entity in the financial conglomerate identified by the coordinator after consultation with the other relevant competent authorities and with the financial conglomerate.

These intra-group transactions shall be subject to supervisory overview by the coordinator.

3. Pending further coordination of Community legislation, Member States may set quantitative limits and qualitative requirements or allow their competent authorities to set quantitative limits and qualitative requirements, or take other supervisory measures that would achieve the objectives of supplementary supervision, with regard to intra-group transactions of regulated entities within a financial conglomerate.

4. Where a financial conglomerate is headed by a mixed financial holding company, the sectoral rules regarding intra-group transactions of the most important financial sector in the financial conglomerate shall apply to that sector as a whole, including the mixed financial holding company.

Article 9

Internal control mechanisms and risk management processes

1. The Member States shall require regulated entities to have, in place at the level of the financial conglomerate, adequate risk management processes and internal control mechanisms, including sound administrative and accounting procedures.

2. The risk management processes shall include:

- (a) sound governance and management with the approval and periodical review of the strategies and policies by the appropriate governing bodies at the level of the financial conglomerate with respect to all the risks they assume;
- (b) adequate capital adequacy policies in order to anticipate the impact of their business strategy on risk profile and capital requirements as determined in accordance with Article 6 and Annex I;
- (c) adequate procedures to ensure that their risk monitoring systems are well integrated into their organisation and that all measures are taken to ensure that the systems implemented in all the undertakings included in the scope of supplementary supervision are consistent so that the risks can be measured, monitored and controlled at the level of the financial conglomerate.

3. The internal control mechanisms shall include:

- (a) adequate mechanisms as regards capital adequacy to identify and measure all material risks incurred and to appropriately relate own funds to risks;
- (b) sound reporting and accounting procedures to identify, measure, monitor and control the intra-group transactions and the risk concentration.

4. The Member States shall ensure that, in all undertakings included in the scope of supplementary supervision pursuant to Article 5, there are adequate internal control mechanisms for the production of any data and information which would be relevant for the purposes of the supplementary supervision.

5. The processes and mechanisms referred to in paragraphs 1 to 4 shall be subject to supervisory overview by the coordinator.

SECTION 3

MEASURES TO FACILITATE SUPPLEMENTARY SUPERVISION

Article 10

Competent authority responsible for exercising supplementary supervision (the coordinator)

1. In order to ensure proper supplementary supervision of the regulated entities in a financial conglomerate, a single coordinator, responsible for coordination and exercise of supplementary supervision, shall be appointed from among the competent authorities of the Member States concerned, including those of the Member State in which the mixed financial holding company has its head office.

2. The appointment shall be based on the following criteria:

- (a) where a financial conglomerate is headed by a regulated entity, the task of coordinator shall be exercised by the competent authority which has authorised that regulated entity pursuant to the relevant sectoral rules;
- (b) where a financial conglomerate is not headed by a regulated entity, the task of coordinator shall be exercised by the competent authority identified in accordance with the following principles:
 - (i) where the parent of a regulated entity is a mixed financial holding company, the task of coordinator shall be exercised by the competent authority which has authorised that regulated entity pursuant to the relevant sectoral rules;
 - (ii) where more than one regulated entity with a head office in the Community have as their parent the same mixed financial holding company, and one of these entities has been authorised in the Member State in which the mixed financial holding company has its head office, the task of coordinator shall be exercised by the competent authority of the regulated entity authorised in that Member State.

Where more than one regulated entity, being active in different financial sectors, have been authorised in the Member State in which the mixed financial holding company has its head office, the task of coordinator shall be exercised by the competent authority of the regulated entity active in the most important financial sector.

Where the financial conglomerate is headed by more than one mixed financial holding company with a head office in different Member States and there is a

regulated entity in each of these States, the task of coordinator shall be exercised by the competent authority of the regulated entity with the largest balance sheet total if these entities are in the same financial sector, or by the competent authority of the regulated entity in the most important financial sector;

(iii) where more than one regulated entity with a head office in the Community have as their parent the same mixed financial holding company and none of these entities has been authorised in the Member State in which the mixed financial holding company has its head office, the task of coordinator shall be exercised by the competent authority which authorised the regulated entity with the largest balance sheet total in the most important financial sector;

(iv) where the financial conglomerate is a group without a parent undertaking at the top, or in any other case, the task of coordinator shall be exercised by the competent authority which authorised the regulated entity with the largest balance sheet total in the most important financial sector.

3. In particular cases, the relevant competent authorities may by common agreement waive the criteria referred to in paragraph 2 if their application would be inappropriate, taking into account the structure of the conglomerate and the relative importance of its activities in different countries, and appoint a different competent authority as coordinator. In these cases, before taking their decision, the competent authorities shall give the conglomerate an opportunity to state its opinion on that decision.

Article 11

Tasks of the coordinator

1. The tasks to be carried out by the coordinator with regard to supplementary supervision shall include:

- (a) coordination of the gathering and dissemination of relevant or essential information in going concern and emergency situations, including the dissemination of information which is of importance for a competent authority's supervisory task under sectoral rules;
- (b) supervisory overview and assessment of the financial situation of a financial conglomerate;
- (c) assessment of compliance with the rules on capital adequacy and of risk concentration and intra-group transactions as set out in Articles 6, 7 and 8;
- (d) assessment of the financial conglomerate's structure, organisation and internal control system as set out in Article 9;

(e) planning and coordination of supervisory activities in going concern as well as in emergency situations, in cooperation with the relevant competent authorities involved;

(f) other tasks, measures and decisions assigned to the coordinator by this Directive or deriving from the application of this Directive.

In order to facilitate and establish supplementary supervision on a broad legal basis, the coordinator and the other relevant competent authorities, and where necessary other competent authorities concerned, shall have coordination arrangements in place. The coordination arrangements may entrust additional tasks to the coordinator and may specify the procedures for the decision-making process among the relevant competent authorities as referred to in Articles 3, 4, 5(4), 6, 12(2), 16 and 18, and for cooperation with other competent authorities.

2. The coordinator should, when it needs information which has already been given to another competent authority in accordance with the sectoral rules, contact this authority whenever possible in order to prevent duplication of reporting to the various authorities involved in supervision.

3. Without prejudice to the possibility of delegating specific supervisory competences and responsibilities as provided for by Community legislation, the presence of a coordinator entrusted with specific tasks concerning the supplementary supervision of regulated entities in a financial conglomerate shall not affect the tasks and responsibilities of the competent authorities as provided for by the sectoral rules.

Article 12

Cooperation and exchange of information between competent authorities

1. The competent authorities responsible for the supervision of regulated entities in a financial conglomerate and the competent authority appointed as the coordinator for that financial conglomerate shall cooperate closely with each other. Without prejudice to their respective responsibilities as defined under sectoral rules, these authorities, whether or not established in the same Member State, shall provide one another with any information which is essential or relevant for the exercise of the other authorities' supervisory tasks under the sectoral rules and this Directive. In this regard, the competent authorities and the coordinator shall communicate on request all relevant information and shall communicate on their own initiative all essential information.

This cooperation shall at least provide for the gathering and the exchange of information with regard to the following items:

- (a) identification of the group structure of all major entities belonging to the financial conglomerate, as well as of the competent authorities of the regulated entities in the group;
- (b) the financial conglomerate's strategic policies;
- (c) the financial situation of the financial conglomerate, in particular on capital adequacy, intra-group transactions, risk concentration and profitability;
- (d) the financial conglomerate's major shareholders and management;
- (e) the organisation, risk management and internal control systems at financial conglomerate level;
- (f) procedures for the collection of information from the entities in a financial conglomerate, and the verification of that information;
- (g) adverse developments in regulated entities or in other entities of the financial conglomerate which could seriously affect the regulated entities;
- (h) major sanctions and exceptional measures taken by competent authorities in accordance with sectoral rules or this Directive.

The competent authorities may also exchange with the following authorities such information as may be needed for the performance of their respective tasks, regarding regulated entities in a financial conglomerate, in line with the provisions laid down in the sectoral rules: central banks, the European System of Central Banks and the European Central Bank.

2. Without prejudice to their respective responsibilities as defined under sectoral rules, the competent authorities concerned shall, prior to their decision, consult each other with regard to the following items, where these decisions are of importance for other competent authorities' supervisory tasks:

- (a) changes in the shareholder, organisational or management structure of regulated entities in a financial conglomerate, which require the approval or authorisation of competent authorities;
- (b) major sanctions or exceptional measures taken by competent authorities.

A competent authority may decide not to consult in cases of urgency or where such consultation may jeopardise the effectiveness of the decisions. In this case, the competent authority shall, without delay, inform the other competent authorities.

3. The coordinator may invite the competent authorities of the Member State in which a parent undertaking has its head

office, and which do not themselves exercise the supplementary supervision pursuant to Article 10, to ask the parent undertaking for any information which would be relevant for the exercise of its coordination tasks as laid down in Article 11, and to transmit that information to the coordinator.

Where the information referred to in Article 14(2) has already been given to a competent authority in accordance with sectoral rules, the competent authorities responsible for exercising supplementary supervision may apply to the first-mentioned authority to obtain the information.

4. Member States shall authorise the exchange of the information between their competent authorities and between their competent authorities and other authorities, as referred to in paragraphs 1, 2 and 3. The collection or possession of information with regard to an entity within a financial conglomerate which is not a regulated entity shall not in any way imply that the competent authorities are required to play a supervisory role in relation to these entities on a stand-alone basis.

Information received in the framework of supplementary supervision, and in particular any exchange of information between competent authorities and between competent authorities and other authorities which is provided for in this Directive, shall be subject to the provisions on professional secrecy and communication of confidential information laid down in the sectoral rules.

Article 13

Management body of mixed financial holding companies

Member States shall require that persons who effectively direct the business of a mixed financial holding company are of sufficiently good repute and have sufficient experience to perform those duties.

Article 14

Access to information

1. Member States shall ensure that there are no legal impediments within their jurisdiction preventing the natural and legal persons included within the scope of supplementary supervision, whether or not a regulated entity, from exchanging amongst themselves any information which would be relevant for the purposes of supplementary supervision.

2. Member States shall provide that, when approaching the entities in a financial conglomerate, whether or not a regulated entity, either directly or indirectly, their competent authorities responsible for exercising supplementary supervision shall have access to any information which would be relevant for the purposes of supplementary supervision.

*Article 15***Verification**

Where, in applying this Directive, competent authorities wish in specific cases to verify the information concerning an entity, whether or not regulated, which is part of a financial conglomerate and is situated in another Member State, they shall ask the competent authorities of that other Member State to have the verification carried out.

The authorities which receive such a request shall, within the framework of their competences, act upon it either by carrying out the verification themselves, by allowing an auditor or expert to carry it out, or by allowing the authority which made the request to carry it out itself.

The competent authority which made the request may, if it so wishes, participate in the verification when it does not carry out the verification itself.

*Article 16***Enforcement measures**

If the regulated entities in a financial conglomerate do not comply with the requirements referred to in Articles 6 to 9 or where the requirements are met but solvency may nevertheless be jeopardised or where the intra-group transactions or the risk concentrations are a threat to the regulated entities' financial position, the necessary measures shall be required in order to rectify the situation as soon as possible:

- by the coordinator with respect to the mixed financial holding company,
- by the competent authorities with respect to the regulated entities; to that end, the coordinator shall inform those competent authorities of its findings.

Without prejudice to Article 17(2), Member States may determine what measures may be taken by their competent authorities with respect to mixed financial holding companies.

The competent authorities involved, including the coordinator, shall where appropriate coordinate their supervisory actions.

*Article 17***Additional powers of the competent authorities**

1. Pending further harmonisation between sectoral rules, the Member States shall provide that their competent authorities shall have the power to take any supervisory measure deemed necessary in order to avoid or to deal with the circumvention of sectoral rules by regulated entities in a financial conglomerate.

2. Without prejudice to their criminal law provisions, Member States shall ensure that penalties or measures aimed at ending observed breaches or the causes of such breaches may be imposed on mixed financial holding companies, or their effective managers, which infringe laws, regulations or administrative provisions enacted to implement this Directive. In certain cases, such measures may require the intervention of the courts. The competent authorities shall cooperate closely to ensure that such penalties or measures produce the desired results.

SECTION 4

THIRD COUNTRIES*Article 18***Parent undertakings outside the Community**

1. Without prejudice to the sectoral rules, in the case referred to in Article 5(3), competent authorities shall verify whether the regulated entities, the parent undertaking of which has its head office outside the Community, are subject to supervision by a third-country competent authority, which is equivalent to that provided for by the provisions of this Directive on the supplementary supervision of regulated entities referred to in Article 5(2). The verification shall be carried out by the competent authority which would be the coordinator if the criteria set out in Article 10(2) were to apply, on the request of the parent undertaking or of any of the regulated entities authorised in the Community or on its own initiative. That competent authority shall consult the other relevant competent authorities, and shall take into account any applicable guidance prepared by the Financial Conglomerates Committee in accordance with Article 21(5). For this purpose the competent authority shall consult the Committee before taking a decision.

2. In the absence of equivalent supervision referred to in paragraph 1, Member States shall apply to the regulated entities, by analogy, the provisions concerning the supplementary supervision of regulated entities referred to in Article 5(2). As an alternative, competent authorities may apply one of the methods set out in paragraph 3.

3. Member States shall allow their competent authorities to apply other methods which ensure appropriate supplementary supervision of the regulated entities in a financial conglomerate. These methods must be agreed by the coordinator, after consultation with the other relevant competent authorities. The competent authorities may in particular require the establishment of a mixed financial holding company which has its head office in the Community, and apply this Directive to the regulated entities in the financial conglomerate headed by that holding company. The methods must achieve the objectives of the supplementary supervision as defined in this Directive and must be notified to the other competent authorities involved and the Commission.

Article 19

Cooperation with third-country competent authorities

1. Article 25(1) and (2) of Directive 2000/12/EC and Article 10a of Directive 98/78/EC shall apply *mutatis mutandis* to the negotiation of agreements with one or more third countries regarding the means of exercising supplementary supervision of regulated entities in a financial conglomerate.
2. The Commission, the Banking Advisory Committee, the Insurance Committee and the Financial Conglomerates Committee shall examine the outcome of the negotiations referred to in paragraph 1 and the resulting situation.

CHAPTER III

POWERS CONFERRED ON THE COMMISSION AND COMMITTEE PROCEDURE

Article 20

Powers conferred on the Commission

1. The Commission shall adopt, in accordance with the procedure referred to in Article 21(2), the technical adaptations to be made to this Directive in the following areas:
 - (a) a more precise formulation of the definitions referred to in Article 2 in order to take account of developments in financial markets in the application of this Directive;
 - (b) a more precise formulation of the definitions referred to in Article 2 in order to ensure uniform application of this Directive in the Community;
 - (c) the alignment of terminology and the framing of definitions in the Directive in accordance with subsequent Community acts on regulated entities and related matters;
 - (d) a more precise definition of the calculation methods set out in Annex I in order to take account of developments on financial markets and prudential techniques;
 - (e) coordination of the provisions adopted pursuant to Articles 7 and 8 and Annex II with a view to encouraging uniform application within the Community.
2. The Commission shall inform the public of any proposal presented in accordance with this Article and will consult interested parties prior to submitting the draft measures to the Financial Conglomerates Committee referred to in Article 21.

Article 21

Committee

1. The Commission shall be assisted by a Financial Conglomerates Committee, hereinafter referred to as the 'Committee'.
 2. Where reference is made to this paragraph, Articles 5 and 7 of Decision 1999/468/EC shall apply, having regard to the provisions of Article 8 thereof.
- The period laid down in Article 5(6) of Decision 1999/468/EC shall be set at three months.
3. The Committee shall adopt its rules of procedure.
 4. Without prejudice to the implementing measures already adopted, on the expiry of a four-year period following the entry into force of this Directive, the application of the provisions thereof requiring the adoption of technical rules and decisions in accordance with the procedure referred to in paragraph 2 shall be suspended. On a proposal from the Commission, the European Parliament and the Council may renew the provisions concerned in accordance with the procedure laid down in Article 251 of the Treaty and, to that end, they shall review them prior to the expiry of the period referred to above.
 5. The Committee may give general guidance as to whether the supplementary supervision arrangements of competent authorities in third countries are likely to achieve the objectives of the supplementary supervision as defined in this Directive, in relation to the regulated entities in a financial conglomerate, the head of which has its head office outside the Community. The Committee shall keep any such guidance under review and take into account any changes to the supplementary supervision carried out by such competent authorities.
 6. The Committee shall be kept informed by Member States of the principles they apply concerning the supervision of intra-group transactions and risk concentration.

CHAPTER IV

AMENDMENTS TO EXISTING DIRECTIVES

Article 22

Amendments to Directive 73/239/EEC

Directive 73/239/EEC is amended as follows:

1. the following Article shall be inserted:

'Article 12a

1. The competent authorities of the other Member State involved shall be consulted prior to the granting of an authorisation to an insurance undertaking, which is:

- (a) a subsidiary of an insurance undertaking authorised in another Member State; or
- (b) a subsidiary of the parent undertaking of an insurance undertaking authorised in another Member State; or
- (c) controlled by the same person, whether natural or legal, who controls an insurance undertaking authorised in another Member State.

2. The competent authority of a Member State involved responsible for the supervision of credit institutions or investment firms shall be consulted prior to the granting of an authorisation to an insurance undertaking which is:

- (a) a subsidiary of a credit institution or investment firm authorised in the Community; or
- (b) a subsidiary of the parent undertaking of a credit institution or investment firm authorised in the Community; or
- (c) controlled by the same person, whether natural or legal, who controls a credit institution or investment firm authorised in the Community.

3. The relevant competent authorities referred to in paragraphs 1 and 2 shall in particular consult each other when assessing the suitability of the shareholders and the reputation and experience of directors involved in the management of another entity of the same group. They shall inform each other of any information regarding the suitability of shareholders and the reputation and experience of directors which is of relevance to the other competent authorities involved for the granting of an authorisation as well as for the ongoing assessment of compliance with operating conditions.'

2. the following subparagraphs shall be added to Article 16(2):

'The available solvency margin shall also be reduced by the following items:

- (a) participations which the insurance undertaking holds in
 - insurance undertakings within the meaning of Article 6 of this Directive, Article 6 of First

Directive 79/267/EEC of 5 March 1979 on the coordination of laws, regulations and administrative provisions relating to the taking up and pursuit of the business of direct life assurance (*), or Article 1(b) of Directive 98/78/EC of the European Parliament and of the Council (**),

- reinsurance undertakings within the meaning of Article 1(c) of Directive 98/78/EC,
- insurance holding companies within the meaning of Article 1(i) of Directive 98/78/EC,
- credit institutions and financial institutions within the meaning of Article 1(1) and (5) of Directive 2000/12/EC of the European Parliament and of the Council (***),
- investment firms and financial institutions within the meaning of Article 1(2) of Directive 93/22/EEC (****) and of Article 2(4) and (7) of Directive 93/6/EEC (*****);

(b) each of the following items which the insurance undertaking holds in respect of the entities defined in (a) in which it holds a participation:

- instruments referred to in paragraph 3,
- instruments referred to in Article 18(3) of Directive 79/267/EEC,
- subordinated claims and instruments referred to in Article 35 and Article 36(3) of Directive 2000/12/EC.

Where shares in another credit institution, investment firm, financial institution, insurance or reinsurance undertaking or insurance holding company are held temporarily for the purposes of a financial assistance operation designed to reorganise and save that entity, the competent authority may waive the provisions on deduction referred to under (a) and (b) of the fourth subparagraph.

As an alternative to the deduction of the items referred to in (a) and (b) of the fourth subparagraph which the insurance undertaking holds in credit institutions, investment firms and financial institutions, Member States may allow their insurance undertakings to apply *mutatis mutandis* methods 1, 2, or 3 of Annex I to Directive 2002/87/EC of the European Parliament and of the Council of 16 December 2002 on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate (*****). Method 1 (Accounting consolidation) shall only be applied if the competent authority is confident about the level of

integrated management and internal control regarding the entities which would be included in the scope of consolidation. The method chosen shall be applied in a consistent manner overtime.

Member States may provide that, for the calculation of the solvency margin as provided for by this Directive, insurance undertakings subject to supplementary supervision in accordance with Directive 98/78/EC or to supplementary supervision in accordance with Directive 2002/87/EC, need not deduct the items referred to in (a) and (b) of the fourth subparagraph which are held in credit institutions, investment firms, financial institutions, insurance or reinsurance undertakings or insurance holding companies which are included in the supplementary supervision.

For the purposes of the deduction of participations referred to in this paragraph, participation shall mean a participation within the meaning of Article 1(f) of Directive 98/78/EC.

(*) OJ L 63, 13.3.1979, p. 1. Directive as last amended by Directive 2002/12/EC of the European Parliament and of the Council (OJ L 77, 20.3.2002, p. 11).

(**) OJ L 330, 5.12.1998, p. 1.

(***) OJ L 126, 26.5.2000, p. 1. Directive as amended by Directive 2000/28/EEC (OJ L 275, 27.10.2000, p. 37).

(****) OJ L 141, 11.6.1993, p. 27. Directive as last amended by Directive 2000/64/EC of the European Parliament and of the Council (OJ L 290, 17.11.2000, p. 27).

(*****) OJ L 141, 11.6.1993, p. 1. Directive as last amended by Directive 98/33/EC of the European Parliament and of the Council (OJ L 204, 21.7.1998, p. 29).

(*****) OJ L 35, 11.2.2003.

Article 23

Amendments to Directive 79/267/EEC

Directive 79/267/EC is amended as follows:

1. the following Article shall be inserted:

'Article 12a

1. The competent authorities of the other Member State involved shall be consulted prior to the granting of an authorisation to a life assurance undertaking, which is:

- (a) a subsidiary of an insurance undertaking authorised in another Member State; or
- (b) a subsidiary of the parent undertaking of an insurance undertaking authorised in another Member State; or

(c) controlled by the same person, whether natural or legal, who controls an insurance undertaking authorised in another Member State.

2. The competent authority of a Member State involved, responsible for the supervision of credit institutions or investment firms, shall be consulted prior to the granting of an authorisation to a life assurance undertaking, which is:

- (a) a subsidiary of a credit institution or investment firm authorised in the Community; or
- (b) a subsidiary of the parent undertaking of a credit institution or investment firm authorised in the Community; or
- (c) controlled by the same person, whether natural or legal, who controls a credit institution or investment firm authorised in the Community.

3. The relevant competent authorities referred to in paragraphs 1 and 2 shall in particular consult each other when assessing the suitability of the shareholders and the reputation and experience of directors involved in the management of another entity of the same group. They shall inform each other of any information regarding the suitability of shareholders and the reputation and experience of directors which is of relevance to the other competent authorities involved for the granting of an authorisation as well as for the ongoing assessment of compliance with operating conditions.'

2. the following subparagraphs shall be added to Article 18(2):

'The available solvency margin shall also be reduced by the following items:

- (a) participations which the assurance undertaking holds, in
 - insurance undertakings within the meaning of Article 6 of this Directive, Article 6 of Directive 73/239/EEC (*), or Article 1(b) of Directive 98/78/EC of the European Parliament and of the Council (**),
 - reinsurance undertakings within the meaning of Article 1(c) of Directive 98/78/EC,
 - insurance holding companies within the meaning of Article 1(i) of Directive 98/78/EC,

- credit institutions and financial institutions within the meaning of Article 1(1) and (5) of Directive 2000/12/EC of the European Parliament and of the Council (**),
 - investment firms and financial institutions within the meaning of Article 1(2) of Directive 93/22/EEC (****) and of Articles 2(4) and 2(7) of Directive 93/6/EEC (*****);
- (b) each of the following items which the assurance undertaking holds in respect of the entities defined in (a) in which it holds a participation:
- instruments referred to in paragraph 3,
 - instruments referred to in Article 16(3) of Directive 73/239/EEC,
 - subordinated claims and instruments referred to in Article 35 and Article 36(3) of Directive 2000/12/EC.

Where shares in another credit institution, investment firm, financial institution, insurance or reinsurance undertaking or insurance holding company are held temporarily for the purposes of a financial assistance operation designed to reorganise and save that entity, the competent authority may waive the provisions on deduction referred to under (a) and (b) of the third subparagraph.

As an alternative to the deduction of the items referred to in (a) and (b) of the third subparagraph which the insurance undertaking holds in credit institutions, investment firms and financial institutions, Member States may allow their insurance undertakings to apply *mutatis mutandis* methods 1, 2, or 3 of Annex I to Directive 2002/87/EC of the European Parliament and of the Council of 16 December 2002 on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate (*****). Method 1 (Accounting consolidation) shall only be applied if the competent authority is confident about the level of integrated management and internal control regarding the entities which would be included in the scope of consolidation. The method chosen shall be applied in a consistent manner over time.

Member States may provide that, for the calculation of the solvency margin as provided for by this Directive, insurance undertakings subject to supplementary supervision in accordance with Directive 98/78/EC or to supplementary supervision in accordance with Directive 2002/87/EC, need not deduct the items referred to in (a) and (b) of the third subparagraph which are held in credit institutions, investment firms, financial institutions, insurance or reinsurance undertakings or insurance holding companies which are included in the supplementary supervision.

For the purposes of the deduction of participations referred to in this paragraph, participation shall mean a participation within the meaning of Article 1(f) of Directive 98/78/EC.

- (*) OJ L 228, 16.8.1973, p. 3. Directive as last amended by Directive 2002/13/EC of the European Parliament and of the Council (OJ L 77, 20.3.2002, p. 17).
- (**) OJ L 330, 5.12.1998, p. 1.
- (***) OJ L 126, 26.5.2000, p. 1. Directive as last amended by Directive 2000/28/EC (OJ L 275, 27.10.2000, p. 37).
- (****) OJ L 141, 11.6.1993, p. 27. Directive as last amended by Directive 2000/64/EC of the European Parliament and of the Council (OJ L 290, 17.11.2000, p. 27).
- (*****) OJ L 141, 11.6.1993, p. 1. Directive as last amended by Directive 98/33/EC of the European Parliament and of the Council (OJ L 204, 21.7.1998, p. 29).
- (*****) OJ L 35, 11.2.2003.

Article 24

Amendments to Directive 92/49/EEC

Directive 92/49/EEC is amended as follows:

1. the following paragraph shall be inserted in Article 15:

'1a. If the acquirer of the holdings referred to in paragraph 1 is an insurance undertaking, a credit institution or an investment firm authorised in another Member State, or the parent undertaking of such an entity, or a natural or legal person controlling such an entity, and if, as a result of that acquisition, the undertaking in which the acquirer proposes to hold a holding would become a subsidiary or subject to the control of the acquirer, the assessment of the acquisition must be subject to the prior consultation referred to in Article 12a of Directive 73/239/EEC.'

2. Article 16(5c) shall be replaced by the following:

'5c. This Article shall not prevent a competent authority from transmitting

- to central banks and other bodies with a similar function in their capacity as monetary authorities,
- where appropriate, to other public authorities responsible for overseeing payment systems,

information intended for the performance of their task, nor shall it prevent such authorities or bodies from communicating to the competent authorities such information as they may need for the purposes of paragraph 4. Information received in this context shall be subject to the conditions of professional secrecy imposed in this Article.'

Article 25

Amendments to Directive 92/96/EEC

Directive 92/96/EEC is amended as follows:

1. the following paragraph shall be inserted in Article 14:

'1a. If the acquirer of the holdings referred to in paragraph 1 is an insurance undertaking, a credit institution or an investment firm authorised in another Member State, or the parent undertaking of such an entity, or a natural or legal person controlling such an entity, and if, as a result of that acquisition, the undertaking in which the acquirer proposes to hold a holding would become a subsidiary or subject to the control of the acquirer, the assessment of the acquisition must be subject to the prior consultation referred to in Article 12a of Directive 79/267/EEC.'

2. Article 15(5c) shall be replaced by the following:

'5c. This Article shall not prevent a competent authority from transmitting

- to central banks and other bodies with a similar function in their capacity as monetary authorities,
- where appropriate, to other public authorities responsible for overseeing payment systems,

information intended for the performance of their task, nor shall it prevent such authorities or bodies from communicating to the competent authorities such information as they may need for the purposes of paragraph 4. Information received in this context shall be subject to the conditions of professional secrecy imposed in this Article.'

Article 26

Amendments to Directive 93/6/EEC

In Article 7(3) of Directive 93/6/EEC the first and the second indents shall be replaced by the following:

- "financial holding company" shall mean a financial institution, the subsidiary undertakings of which are either exclusively or mainly investment firms or other financial institutions, at least one of which is an investment firm, and which is not a mixed financial holding company within the meaning of Directive 2002/87/EC of the European Parliament and of the Council of 16 December 2002 on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate (*),

- "mixed-activity holding company" shall mean a parent undertaking, other than a financial holding company or an investment firm or a mixed financial holding company within the meaning of Directive 2002/87/EC, the subsidiaries of which include at least one investment firm.

(*) OJ L 35, 11.2.2003.'

Article 27

Amendments to Directive 93/22/EEC

Directive 93/22/EEC is amended as follows:

1. in Article 6 the following paragraphs shall be added:

'The competent authority of a Member State involved, responsible for the supervision of credit institutions or insurance undertakings, shall be consulted prior to the granting of an authorisation to an investment firm which is:

- (a) a subsidiary of a credit institution or insurance undertaking authorised in the Community; or
- (b) a subsidiary of the parent undertaking of a credit institution or insurance undertaking authorised in the Community; or
- (c) controlled by the same person, whether natural or legal, who controls a credit institution or insurance undertaking authorised in the Community.

The relevant competent authorities referred to in the first and second paragraphs shall in particular consult each other when assessing the suitability of the shareholders and the reputation and experience of directors involved in the management of another entity of the same group. They shall inform each other of any information regarding the suitability of shareholders and the reputation and experience of directors which is of relevance to the other competent authorities involved for the granting of an authorisation as well as for the ongoing assessment of compliance with operating conditions.'

2. Article 9(2) shall be replaced by the following:

'2. If the acquirer of the holding referred to in paragraph 1 is an investment firm, a credit institution or an insurance undertaking authorised in another Member State, or the parent undertaking of an investment firm, credit institution or insurance undertaking authorised in another Member State, or a natural or legal person controlling an investment firm, credit institution or insurance undertaking authorised in another Member State, and if, as a result of that acquisition, the undertaking in which the acquirer proposes to acquire a holding would become the acquirer's subsidiary or come under his control, the assessment of the acquisition must be subject to the prior consultation provided for in Article 6.'

Article 28

Amendments to Directive 98/78/EC

Directive 98/78/EC is amended as follows:

1. in Article 1 points (g), (h), (i) and (j) shall be replaced by the following:

(g) "participating undertaking" shall mean an undertaking which is either a parent undertaking or other undertaking which holds a participation, or an undertaking linked with another undertaking by a relationship within the meaning of Article 12(1) of Directive 83/349/EEC;

(h) "related undertaking" shall mean either a subsidiary or other undertaking in which a participation is held, or an undertaking linked with another undertaking by a relationship within the meaning of Article 12(1) of Directive 83/349/EEC;

(i) "insurance holding company" shall mean a parent undertaking, the main business of which is to acquire and hold participations in subsidiary undertakings, where those subsidiary undertakings are exclusively or mainly insurance undertakings, reinsurance undertakings, or non-member-country insurance undertakings, at least one of such subsidiary undertakings being an insurance undertaking, and which is not a mixed financial holding company within the meaning of Directive 2002/87/EC of the European Parliament and of the Council of 16 December 2002 on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate (*);

(j) "mixed-activity insurance holding company" shall mean a parent undertaking, other than an insurance undertaking, a non-member country insurance undertaking, a reinsurance undertaking, an insurance holding company or a mixed financial holding company within the meaning of Directive 2002/87/EC, which includes at least one insurance undertaking among its subsidiary undertakings.

(*) OJ L 35, 11.2.2003.'

2. in Article 6(3) the following sentence shall be added:

'The competent authority which made the request may, if it so wishes, participate in the verification when it does not carry out the verification itself.'

3. in Article 8(2) the first subparagraph shall be replaced by the following:

'Member States shall require insurance undertakings to have in place adequate risk management processes and internal control mechanisms, including sound reporting and accounting procedures, in order to identify, measure,

monitor and control transactions as provided for in paragraph 1 appropriately. Member States shall also require at least annual reporting by insurance undertakings to the competent authorities of significant transactions. These processes and mechanisms shall be subject to overview by the competent authorities.'

4. the following Articles shall be inserted:

'Article 10a

Cooperation with third countries' competent authorities

1. The Commission may submit proposals to the Council, either at the request of a Member State or on its own initiative, for the negotiation of agreements with one or more third countries regarding the means of exercising supplementary supervision over:

(a) insurance undertakings which have, as participating undertakings, undertakings within the meaning of Article 2 which have their head office situated in a third country; and

(b) non-member country insurance undertakings which have, as participating undertakings, undertakings within the meaning of Article 2 which have their head office in the Community.

2. The agreements referred to in paragraph 1 shall in particular seek to ensure both:

(a) that the competent authorities of the Member States are able to obtain the information necessary for the supplementary supervision of insurance undertakings which have their head office in the Community and which have subsidiaries or hold participations in undertakings outside the Community; and

(b) that the competent authorities of third countries are able to obtain the information necessary for the supplementary supervision of insurance undertakings which have their head office in their territories and which have subsidiaries or hold participations in undertakings in one or more Member States.

3. The Commission and the Insurance Committee shall examine the outcome of the negotiations referred to in paragraph 1 and the resulting situation.

Article 10b

Management body of insurance holding companies

The Member States shall require that persons who effectively direct the business of an insurance holding

company are of sufficiently good repute and have sufficient experience to perform these duties.'

5. in Annex I.1.B. the following paragraph shall be added:

'Where there are no capital ties between some of the undertakings in an insurance group, the competent authority shall determine which proportional share will have to be taken account of.'

6. in Annex I.2. the following point shall be added:

'2.4a. Related credit institutions, investment firms and financial institutions

When calculating the adjusted solvency of an insurance undertaking which is a participating undertaking in a credit institution, investment firm or financial institution, the rules laid down in Article 16(1) of Directive 73/239/EEC and in Article 18 of Directive 79/267/EEC on the deduction of such participations shall apply *mutatis mutandis*, as well as the provisions on the ability of Member States under certain conditions to allow alternative methods and to allow such participations not to be deducted.'

Article 29

Amendments to Directive 2000/12/EC

Directive 2000/12/EC is amended as follows:

1. Article 1 shall be amended as follows:

(a) Point (9) shall be replaced by the following:

'9. "participation for the purposes of supervision on a consolidated basis and for the purposes of points 15 and 16 of Article 34(2)" shall mean participation within the meaning of the first sentence of Article 17 of Directive 78/660/EEC, or the ownership, direct or indirect, of 20 % or more of the voting rights or capital of an undertaking.'

(b) Points (21) and (22) shall be replaced by the following:

'21. "financial holding company" shall mean a financial institution, the subsidiary undertakings of which are either exclusively or mainly credit institutions or financial institutions, at least one of such subsidiaries being a credit institution, and which is not a mixed financial holding company within the meaning of Directive 2002/87/EC of the European Parliament and of the Council of 16 December 2002 on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate (*);

22. "mixed-activity holding company" shall mean a parent undertaking, other than a financial holding company or a credit institution or a mixed financial holding company within the meaning of Directive 2002/87/EC, the subsidiaries of which include at least one credit institution;

(*) OJ L 35, 11.2.2003.'

2. in Article 12 the following paragraphs shall be added:

'The competent authority of a Member State involved, responsible for the supervision of insurance undertakings or investment firms, shall be consulted prior to the granting of an authorisation to a credit institution which is:

- (a) a subsidiary of an insurance undertaking or investment firm authorised in the Community; or
- (b) a subsidiary of the parent undertaking of an insurance undertaking or investment firm authorised in the Community; or
- (c) controlled by the same person, whether natural or legal, who controls an insurance undertaking or investment firm authorised in the Community.

The relevant competent authorities referred to in the first and second paragraphs shall in particular consult each other when assessing the suitability of the shareholders and the reputation and experience of directors involved in the management of another entity of the same group. They shall inform each other of any information regarding the suitability of shareholders and the reputation and experience of directors which is of relevance to the other competent authorities involved for the granting of an authorisation as well as for the ongoing assessment of compliance with operating conditions.'

3. Article 16(2) shall be replaced by the following:

'2. If the acquirer of the holdings referred to in paragraph 1 is a credit institution, insurance undertaking or investment firm authorised in another Member State or the parent undertaking of a credit institution, insurance undertaking or investment firm authorised in another Member State or a natural or legal person controlling a credit institution, insurance undertaking or investment firm authorised in another Member State, and if, as a result of that acquisition, the institution in which the acquirer proposes to hold a holding would become a subsidiary or subject to the control of the acquirer, the assessment of the acquisition must be subject to the prior consultation referred to in Article 12.'

4. Article 34(2) shall be amended as follows:

(a) in the first subparagraph points 12 and 13 shall be replaced by the following:

12. holdings in other credit and financial institutions amounting to more than 10 % of their capital;

13. subordinated claims and instruments referred to in Article 35 and Article 36(3) which a credit institution holds in respect of credit and financial institutions in which it has holdings exceeding 10 % of the capital in each case;

14. holdings in other credit and financial institutions of up to 10 % of their capital, the subordinated claims and the instruments referred to in Article 35 and Article 36(3) which a credit institution holds in respect of credit and financial institutions other than those referred to in points 12 and 13 of this subparagraph in respect of the amount of the total of such holdings, subordinated claims and instruments which exceed 10 % of that credit institution's own funds calculated before the deduction of items in points 12 to 16 of this subparagraph;

15. participations within the meaning of Article 1(9) which a credit institution holds in

— insurance undertakings within the meaning of Article 6 of Directive 73/239/EEC, Article 6 of Directive 79/267/EEC or Article 1(b) of Directive 98/78/EC of the European Parliament and of the Council (*),

— reinsurance undertakings within the meaning of Article 1(c) of Directive 98/78/EC,

— insurance holding companies within the meaning of Article 1(i) of Directive 98/78/EC;

16. each of the following items which the credit institution holds in respect of the entities defined in point (15) in which it holds a participation:

— instruments referred to in Article 16(3) of Directive 73/239/EEC,

— instruments referred to in Article 18(3) of Directive 79/267/EEC;

(*) OJ L 330, 5.12.1998, p. 1.

(b) the second subparagraph shall be replaced by the following:

'Where shares in another credit institution, financial institution, insurance or reinsurance undertaking or insurance holding company are held temporarily for the purposes of a financial assistance operation designed to reorganise and save that entity, the competent authority may waive the provisions on deduction referred to in points 12 to 16.

As an alternative to the deduction of the items referred to in points 15 and 16, Member States may allow their credit institutions to apply *mutatis mutandis* methods 1, 2, or 3 of Annex I to Directive 2002/87/EC. Method 1 (Accounting consolidation) shall only be applied if the competent authority is confident about the level of integrated management and internal control regarding the entities which would be included in the scope of consolidation. The method chosen shall be applied in a consistent manner over time.

Member States may provide that for the calculation of own funds on a stand-alone basis, credit institutions subject to supervision on a consolidated basis in accordance with Chapter 3 or to supplementary supervision in accordance with Directive 2002/87/EC, need not deduct the items referred to in points 12 to 16 which are held in credit institutions, financial institutions, insurance or reinsurance undertakings or insurance holding companies, which are included in the scope of consolidated or supplementary supervision.

This provision shall apply to all the prudential rules harmonised by Community acts.'

5. Article 51(3) shall be replaced by the following:

'3. The Member States need not apply the limits laid down in paragraphs 1 and 2 to holdings in insurance companies as defined in Directive 73/239/EEC and Directive 79/267/EEC, or in reinsurance companies as defined in Directive 98/78/EC.'

6. the last sentence in Article 52(2) shall be replaced by the following:

'Without prejudice to Article 54a, the consolidation of the financial situation of the financial holding company shall not in any way imply that the competent authorities are required to play a supervisory role in relation to the financial holding company on a stand-alone basis.'

7. Article 54 shall be amended as follows:

- (a) in paragraph 1 the following subparagraph shall be added:

'In the case where undertakings are linked by a relationship within the meaning of Article 12 (1) of Directive 83/349/EEC, the competent authorities shall determine how consolidation is to be carried out.'

- (b) in paragraph 4, first subparagraph, the third indent shall be deleted;

8. the following Article shall be inserted:

'Article 54a

Management body of financial holding companies

The Member States shall require that persons who effectively direct the business of a financial holding company are of sufficiently good repute and have sufficient experience to perform those duties.'

9. the following Article shall be inserted:

'Article 55a

Intra-group transactions with mixed-activity holding companies

Without prejudice to the provisions of Title V, Chapter 2, Section 3, of this Directive, Member States shall provide that, where the parent undertaking of one or more credit institutions is a mixed-activity holding company, the competent authorities responsible for the supervision of these credit institutions shall exercise general supervision over transactions between the credit institution and the mixed-activity holding company and its subsidiaries.

Competent authorities shall require credit institutions to have in place adequate risk management processes and internal control mechanisms, including sound reporting and accounting procedures, in order to identify, measure, monitor and control transactions with their parent mixed-activity holding company and its subsidiaries appropriately. Competent authorities shall require the reporting by the credit institution of any significant transaction with these entities other than the one referred to in Article 48. These procedures and significant transactions shall be subject to overview by the competent authorities.

Where these intra-group transactions are a threat to a credit institution's financial position, the competent authority responsible for the supervision of the institution shall take appropriate measures.'

10. in Article 56(7) the following sentence shall be added:

'The competent authority which made the request may, if it so wishes, participate in the verification when it does not carry out the verification itself.'

11. the following Article shall be inserted:

'Article 56a

Third-country parent undertakings

Where a credit institution, the parent undertaking of which is a credit institution or a financial holding company, the head office of which is outside the Community, is not subject to consolidated supervision under Article 52, the competent authorities shall verify whether the credit institution is subject to consolidated supervision by a third-country competent authority which is equivalent to that governed by the principles laid down in Article 52. The verification shall be carried out by the competent authority which would be responsible for consolidated supervision if the fourth subparagraph were to apply, at the request of the parent undertaking or of any of the regulated entities authorised in the Community or on its own initiative. That competent authority shall consult the other competent authorities involved.

The Banking Advisory Committee may give general guidance as to whether the consolidated supervision arrangements of competent authorities in third countries are likely to achieve the objectives of consolidated supervision as defined in this Chapter, in relation to credit institutions, the parent undertaking of which has its head office outside the Community. The Committee shall keep any such guidance under review and take into account any changes to the consolidated supervision arrangements applied by such competent authorities.

The competent authority carrying out the verification specified in the second subparagraph shall take into account any such guidance. For this purpose the competent authority shall consult the Committee before taking a decision.

In the absence of such equivalent supervision, Member States shall apply the provisions of Article 52 to the credit institution by analogy.

As an alternative, Member States shall allow their competent authorities to apply other appropriate supervisory techniques which achieve the objectives of the supervision on a consolidated basis of credit institutions. Those methods must be agreed upon by the competent authority which would be responsible for consolidated supervision, after consultation with the other competent authorities involved. Competent authorities may in particular require the establishment of a financial holding company which has its head office in the Community, and apply the provisions on consolidated supervision to the consolidated position of that financial holding company.

The methods must achieve the objectives of consolidated supervision as defined in this Chapter and must be notified to the other competent authorities involved and the Commission.'

CHAPTER V

ASSET MANAGEMENT COMPANIES

Article 30

Asset management companies

Pending further coordination of sectoral rules, Member States shall provide for the inclusion of asset management companies:

- (a) in the scope of consolidated supervision of credit institutions and investment firms, and/or in the scope of supplementary supervision of insurance undertakings in an insurance group; and
- (b) where the group is a financial conglomerate, in the scope of supplementary supervision within the meaning of this Directive.

For the application of the first paragraph, Member States shall provide, or give their competent authorities the power to decide, according to which sectoral rules (banking sector, insurance sector or investment services sector) asset management companies shall be included in the consolidated and/or supplementary supervision referred to in (a) of the first paragraph. For the purposes of this provision, the relevant sectoral rules regarding the form and extent of the inclusion of financial institutions (where asset management companies are included in the scope of consolidated supervision of credit institutions and investment firms) and of reinsurance undertakings (where asset management companies are included in the scope of supplementary supervision of insurance undertakings) shall apply *mutatis mutandis* to asset management companies. For the purposes of supplementary supervision referred to in (b) of the first paragraph, the asset management company shall be treated as part of whichever sector it is included in by virtue of (a) of the first paragraph.

Where an asset management company is part of a financial conglomerate, any reference to the notion of regulated entity and any reference to the notion of competent authorities and relevant competent authorities shall therefore, for the purposes of this Directive, be understood as including, respectively, asset management companies and the competent authorities responsible for the supervision of asset management companies. This applies *mutatis mutandis* as regards groups referred to in (a) of the first paragraph.

CHAPTER VI

TRANSITIONAL AND FINAL PROVISIONS

Article 31

Report by the Commission

1. By 11 August 2007, the Commission shall submit to the Financial Conglomerates Committee referred to in Article 21 a report on Member States' practices, and, if necessary, on the need for further harmonisation, with regard to

- the inclusion of asset management companies in group-wide supervision,
- the choice and the application of the capital adequacy methods set out in Annex I,
- the definition of significant intra-group transactions and significant risk concentration and the supervision of intra-group transactions and risk concentration referred to in Annex II, in particular regarding the introduction of quantitative limits and qualitative requirements for this purpose,
- the intervals at which financial conglomerates shall carry out the calculations of capital adequacy requirements as set out in Article 6(2) and report to the coordinator on significant risk concentration as set out in Article 7(2).

The Commission shall consult the Committee before making its proposals.

2. Within one year of agreement being reached at international level on the rules for eliminating the double gearing of own funds in financial groups, the Commission shall examine how to bring the provisions of this Directive into line with those international agreements and, if necessary, make appropriate proposals.

Article 32

Transposition

Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive before 11 August 2004. They shall forthwith inform the Commission thereof.

Member States shall provide that the provisions referred to in the first subparagraph shall first apply to the supervision of accounts for the financial year beginning on 1 January 2005 or during that calendar year.

When Member States adopt these measures, they shall contain a reference to this Directive or shall be accompanied by such reference on the occasion of their official publication. The methods of making such reference shall be laid down by Member States.

Article 33

Entry into force

This Directive shall enter into force on the day of its publication in the *Official Journal of the European Union*.

Article 34

Addressees

This Directive is addressed to the Member States.

Done at Brussels, 16 December 2002.

For the European Parliament

The President

P. COX

For the Council

The President

M. FISCHER BOEL

ANNEX I

CAPITAL ADEQUACY

The calculation of the supplementary capital adequacy requirements of the regulated entities in a financial conglomerate referred to in Article 6(1) shall be carried out in accordance with the technical principles and one of the methods described in this Annex.

Without prejudice to the provisions of the next paragraph, Member States shall allow their competent authorities, where they assume the role of coordinator with regard to a particular financial conglomerate, to decide, after consultation with the other relevant competent authorities and the conglomerate itself, which method shall be applied by that financial conglomerate.

Member States may require that the calculation be carried out according to one particular method among those described in this Annex if a financial conglomerate is headed by a regulated entity which has been authorised in that Member State. Where a financial conglomerate is not headed by a regulated entity within the meaning of Article 1, Member States shall authorise the application of any of the methods described in this Annex, except in situations where the relevant competent authorities are located in the same Member State, in which case that Member State may require the application of one of the methods.

I. Technical principles**1. Extent and form of the supplementary capital adequacy requirements calculation**

Whichever method is used, when the entity is a subsidiary undertaking and has a solvency deficit, or, in the case of a non-regulated financial sector entity, a notional solvency deficit, the total solvency deficit of the subsidiary has to be taken into account. Where in this case, in the opinion of the coordinator, the responsibility of the parent undertaking owning a share of the capital is limited strictly and unambiguously to that share of the capital, the coordinator may give permission for the solvency deficit of the subsidiary undertaking to be taken into account on a proportional basis.

Where there are no capital ties between entities in a financial conglomerate, the coordinator, after consultation with the other relevant competent authorities, shall determine which proportional share will have to be taken into account, bearing in mind the liability to which the existing relationship gives rise.

2. Other technical principles

Regardless of the method used for the calculation of the supplementary capital adequacy requirements of regulated entities in a financial conglomerate as laid down in Section II of this Annex, the coordinator, and where necessary other competent authorities concerned, shall ensure that the following principles will apply:

- (i) the multiple use of elements eligible for the calculation of own funds at the level of the financial conglomerate (multiple gearing) as well as any inappropriate intra-group creation of own funds must be eliminated; in order to ensure the elimination of multiple gearing and the intra-group creation of own funds, competent authorities shall apply by analogy the relevant principles laid down in the relevant sectoral rules;
- (ii) pending further harmonisation of sectoral rules, the solvency requirements for each different financial sector represented in a financial conglomerate shall be covered by own funds elements in accordance with the corresponding sectoral rules; when there is a deficit of own funds at the financial conglomerate level, only own funds elements which are eligible according to each of the sectoral rules (cross-sector capital) shall qualify for verification of compliance with the additional solvency requirements;

where sectoral rules provide for limits on the eligibility of certain own funds instruments, which would qualify as cross-sector capital, these limits would apply *mutatis mutandis* when calculating own funds at the level of the financial conglomerate;

when calculating own funds at the level of the financial conglomerate, competent authorities shall also take into account the effectiveness of the transferability and availability of the own funds across the different legal entities in the group, given the objectives of the capital adequacy rules;

where, in the case of a non-regulated financial sector entity, a notional solvency requirement is calculated in accordance with section II of this Annex, notional solvency requirement means the capital requirement with which such an entity would have to comply under the relevant sectoral rules as if it were a regulated entity of that particular financial sector; in the case of asset management companies, solvency requirement means the capital requirement set out in Article 5a(1)(a) of Directive 85/611/EEC; the notional solvency requirement of a mixed financial holding company shall be calculated according to the sectoral rules of the most important financial sector in the financial conglomerate.

II. Technical calculation methods

Method 1: 'Accounting consolidation' method

The calculation of the supplementary capital adequacy requirements of the regulated entities in a financial conglomerate shall be carried out on the basis of the consolidated accounts.

The supplementary capital adequacy requirements shall be calculated as the difference between:

- (i) the own funds of the financial conglomerate calculated on the basis of the consolidated position of the group; the elements eligible are those that qualify in accordance with the relevant sectoral rules;

and

- (ii) the sum of the solvency requirements for each different financial sector represented in the group; the solvency requirements for each different financial sector are calculated in accordance with the corresponding sectoral rules.

The sectoral rules referred to are in particular Directives 2000/12/EC, Title V, Chapter 3, as regards credit institutions, 98/78/EC as regards insurance undertakings, and 93/6/EEC as regards credit institutions and investment firms.

In the case of non-regulated financial sector entities which are not included in the aforementioned sectoral solvency requirement calculations, a notional solvency requirement shall be calculated.

The difference shall not be negative.

Method 2: 'Deduction and aggregation' method

The calculation of the supplementary capital adequacy requirements of the regulated entities in a financial conglomerate shall be carried out on the basis of the accounts of each of the entities in the group.

The supplementary capital adequacy requirements shall be calculated as the difference between:

- (i) the sum of the own funds of each regulated and non-regulated financial sector entity in the financial conglomerate; the elements eligible are those which qualify in accordance with the relevant sectoral rules;

and

- (ii) the sum of
 - the solvency requirements for each regulated and non-regulated financial sector entity in the group; the solvency requirements shall be calculated in accordance with the relevant sectoral rules, and
 - the book value of the participations in other entities of the group.

In the case of non-regulated financial sector entities, a notional solvency requirement shall be calculated. Own funds and solvency requirements shall be taken into account for their proportional share as provided for in Article 6(4) and in accordance with Section I of this Annex.

The difference shall not be negative.

Method 3: 'Book value/Requirement deduction' method

The calculation of the supplementary capital adequacy requirements of the regulated entities in a financial conglomerate shall be carried out on the basis of the accounts of each of the entities in the group.

The supplementary capital adequacy requirements shall be calculated as the difference between:

(i) the own funds of the parent undertaking or the entity at the head of the financial conglomerate; the elements eligible are those which qualify in accordance with the relevant sectoral rules;

and

(ii) the sum of

- the solvency requirement of the parent undertaking or the head referred to in (i), and
- the higher of the book value of the former's participation in other entities in the group and these entities' solvency requirements; the solvency requirements of the latter shall be taken into account for their proportional share as provided for in Article 6(4) and in accordance with Section I of this Annex.

In the case of non-regulated financial sector entities, a notional solvency requirement shall be calculated. When valuing the elements eligible for the calculation of the supplementary capital adequacy requirements, participations may be valued by the equity method in accordance with the option set out in Article 59(2)(b) of Directive 78/660/EEC.

The difference shall not be negative.

Method 4: Combination of methods 1, 2 and 3

Competent authorities may allow a combination of methods 1, 2 and 3, or a combination of two of these methods.

ANNEX II

TECHNICAL APPLICATION OF THE PROVISIONS ON INTRA-GROUP TRANSACTIONS AND RISK CONCENTRATION

The coordinator, after consultation with the other relevant competent authorities, shall identify the type of transactions and risks regulated entities in a particular financial conglomerate shall report in accordance with the provisions of Article 7(2) and Article 8(2) on the reporting of intra-group transactions and risk concentration. When defining or giving their opinion about the type of transactions and risks, the coordinator and the relevant competent authorities shall take into account the specific group and risk management structure of the financial conglomerate. In order to identify significant intra-group transactions and significant risk concentration to be reported in accordance with the provisions of Articles 7 and 8, the coordinator, after consultation with the other relevant competent authorities and the conglomerate itself, shall define appropriate thresholds based on regulatory own funds and/or technical provisions.

When overviews the intra-group transactions and risk concentrations, the coordinator shall in particular monitor the possible risk of contagion in the financial conglomerate, the risk of a conflict of interests, the risk of circumvention of sectoral rules, and the level or volume of risks.

Member States may allow their competent authorities to apply at the level of the financial conglomerate the provisions of the sectoral rules on intra-group transactions and risk concentration, in particular to avoid circumvention of the sectoral rules.

DIRECTIVE 2002/88/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 9 December 2002

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

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 95 thereof,

Having regard to the proposal from the Commission ⁽¹⁾,

Having regard to the opinion of the Economic and Social Committee ⁽²⁾,

Following consultation of the Committee of the Regions,

Acting in accordance with the procedure laid down in Article 251 of the Treaty ⁽³⁾,

Whereas:

(1) The Auto oil II programme was aimed at identifying cost effective strategies to meet the air quality objectives of the Community. The Commission Communication Review on the Auto oil II programme concluded that there is a need for further measures, especially to address the issues of ozone and particulate emissions. Recent work on the development of national emissions ceilings has shown that further measures are needed to meet the air quality objectives decided upon in the Community legislation.

(2) Stringent standards on emissions from vehicles on highways have been gradually introduced. It has already been decided that those standards should be strengthened. The relative contribution of pollutants from non-road mobile machinery will thus be more predominant in the future.

(3) Directive 97/68/EC ⁽⁴⁾ introduced emission limit values for gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery.

(4) Although Directive 97/68/EC initially applied only to certain compression ignition engines, recital 5 of that Directive envisages the subsequent extension of its scope to include in particular gasoline engines.

(5) The emissions from small spark ignition engines (gasoline engines) in different types of machinery contribute significantly to identified air quality problems, both current and future, especially ozone formation.

(6) Emissions from small spark ignition engines are subject to strict environmental standards in the USA, showing that it is possible significantly to reduce the emissions.

(7) The absence of Community legislation means it is possible to place on the market engines with old fashioned technology from an environmental point of view, thereby jeopardising the air quality objectives in the Community, or to implement national legislation in this field, with the potential to create barriers to trade.

(8) Directive 97/68/EC is closely aligned with the corresponding US legislation, and continuing alignment will have benefits for industry, as well as for the environment.

(9) A certain lead time is necessary for the European industry, especially for those manufacturers that are not yet operating on a global basis, to be able to meet the emission standards.

(10) A two-step approach is used in Directive 97/68/EC for compression ignition engines as well as in the US regulations on spark ignition engines. Although it might have been possible to adopt a one-step approach in the Community legislation, this would have left the field unregulated for another four to five years.

(11) To achieve the necessary flexibility for worldwide alignment, a possible derogation, to be made under the comitology procedure, is included.

⁽¹⁾ OJ C 180 E, 26.6.2001, p. 31.

⁽²⁾ OJ C 260, 17.9.2001, p. 1.

⁽³⁾ Opinion of the European Parliament of 2 October 2001 (OJ C 87 E, 11.4.2002, p. 18), Council Common Position of 25 March 2002 (OJ C 145 E, 18.6.2002, p. 17) and Decision of the European Parliament of 2 July 2002 (not yet published in the Official Journal).

⁽⁴⁾ OJ L 59, 27.2.1998, p. 1. Directive as amended by Commission Directive 2001/63/EC (OJ L 227, 23.8.2001, p. 41).

(12) The measures necessary for the implementation of this Directive should be adopted in accordance with Council Decision 1999/468/EC of 28 June 1999 laying down the procedures for the exercise of implementing powers conferred on the Commission ⁽¹⁾.

(13) Directive 97/68/EC should be amended accordingly,

HAVE ADOPTED THIS DIRECTIVE:

Article 1

Directive 97/68/EC is hereby amended as follows:

1. In Article 2:

(a) the eighth indent shall be replaced by the following:

— “placing on the market” shall mean the action of making an engine available for the first time on the market, for payment or free of charge, with a view to distribution and/or use in the Community;’

(b) the following indents shall be added:

— “replacement engines” shall mean a newly built engine to replace an engine in a machine, and which has been supplied for this purpose only,

— “hand-held engine” shall mean an engine that meets at least one of the following requirements:

(a) the engine must be used in a piece of equipment that is carried by the operator throughout the performance of its intended function(s);

(b) the engine must be used in a piece of equipment that must operate multipositionally, such as upside down or sideways, to complete its intended function(s);

(c) the engine must be used in a piece of equipment for which the combined engine and equipment dry weight is under 20 kilograms and at least one of the following attributes is also present:

(i) the operator must alternatively provide support or carry the equipment throughout the performance of its intended function(s);

(ii) the operator must provide support or attitudinal control for the equipment throughout the performance of its intended function(s);

(iii) the engine must be used in a generator or a pump;

— “non-hand-held engine” shall mean an engine which does not fall under the definition of a hand-held engine,

— “professional use multipositional hand-held engine” shall mean a hand-held engine which meets the requirements of both (a) and (b) of the hand-held engine definition and in relation to which the engine manufacturer has satisfied an approval authority that a Category 3 Emissions Durability Period (according to section 2.1 of Appendix 4 to Annex IV) would be applicable to the engine,

— “emission durability period” shall mean the number of hours indicated in Annex IV, Appendix 4, used to determine the deterioration factors,

— “small volume engine family” shall mean a spark-ignition (SI) engine family with a total yearly production of fewer than 5 000 units,

— “small volume engine manufacturer of SI engines” shall mean a manufacturer with a total yearly production of fewer than 25 000 units.’

2. Article 4 is hereby amended as follows:

(a) paragraph 2 shall be amended as follows:

(i) in the first sentence ‘Annex VI’ shall be replaced by ‘Annex VII’;

(ii) in the second sentence ‘Annex VII’ shall be replaced by ‘Annex VIII’;

(b) paragraph 4 shall be amended as follows:

(i) in point (a) ‘Annex VIII’ shall be replaced by ‘Annex IX’;

(ii) in point (b) ‘Annex IX’ shall be replaced by ‘Annex X’;

(c) in paragraph 5, ‘Annex X’ shall be replaced by ‘Annex XI’.

3. Article 7(2) shall be replaced by the following:

‘2. Member States shall accept type-approvals and, where applicable, the pertaining approval marks listed in Annex XII as being in conformity with this Directive.’

4. Article 9 is hereby amended as follows:

(a) the heading ‘Timetable’ shall be replaced by the heading ‘Timetable-compression ignition engines’;

⁽¹⁾ OJ L 184, 17.7.1999, p. 23.

- (b) in paragraph 1, 'Annex VI' shall be replaced by 'Annex VII';
- (c) paragraph 2 shall be amended as follows:
- (i) 'Annex VI' shall be replaced by 'Annex VII';
- (ii) 'section 4.2.1 of Annex I' shall be replaced by 'section 4.1.2.1 of Annex I';
- (d) paragraph 3 shall be amended as follows:
- (i) 'Annex VI' shall be replaced by 'Annex VII';
- (ii) 'section 4.2.3 of Annex I' shall be replaced by 'section 4.1.2.3 of Annex I';
- (e) in the first subparagraph of paragraph 4, the phrase 'placing on the market of new engines' shall be replaced by 'placing on the market of engines'.
5. The following Article shall be inserted:

'Article 9a

Timetable — Spark ignition engines

1. DIVIDING INTO CLASSES

For the purpose of this Directive, spark-ignition engines shall be divided into the following classes.

Main class S: small engines with a net power ≤ 19 kW

The main class S shall be divided into two categories:

H: engines for hand-held machinery

N: engines for non-hand-held machinery

Class/category	Displacement (cubic cm)
Hand-held engines Class SH:1	< 20
Class SH:2	≥ 20 < 50
Class SH:3	≥ 50
Non-hand-held engines Class SN:1	< 66
Class SN:2	≥ 66 < 100
Class SN:3	≥ 100 < 225
Class SN:4	≥ 225

2. GRANT OF TYPE APPROVALS

After 11 August 2004, Member States may not refuse to grant type-approval for an SI engine type or engine family or to issue the document as described in Annex VII, and may not impose any other type-approval requirements with regard to air-polluting emissions for non-road mobile machinery in which an engine is installed, if the engine meets the requirements specified in this Directive as regards the emissions of gaseous pollutants.

3. TYPE-APPROVALS STAGE I

Member States shall refuse to grant type-approval for an engine type or engine family and to issue the documents as described in Annex VII, and shall refuse to grant any other type-approval for non-road mobile machinery in which an engine is installed after 11 August 2004 if the engine fails to meet the requirements specified in this Directive and where the emissions of gaseous pollutants from the engine do not comply with the limit values as set out in the table in section 4.2.2.1 of Annex I.

4. TYPE-APPROVALS STAGE II

Member States shall refuse to grant type-approval for an engine type or engine family and to issue the documents as described in Annex VII, and shall refuse to grant any other type-approval for non-road mobile machinery in which an engine is installed:

after 1 August 2004 for engine classes SN:1 and SN:2

after 1 August 2006 for engine class SN:4

after 1 August 2007 for engine classes SH:1, SH:2 and SN:3

after 1 August 2008 for engine class SH:3,

if the engine fails to meet the requirements specified in this Directive and where the emissions of gaseous pollutants from the engine do not comply with the limit values as set out in the table in section 4.2.2.2 of Annex I.

5. PLACING ON THE MARKET: ENGINE PRODUCTION DATES

Six months after the dates for the relevant category of engine in paragraphs 3 and 4, with the exception of machinery and engines intended for export to third countries, Member States shall permit placing on the market of engines, whether or not already installed in machinery, only if they meet the requirements of this Directive.

6. LABELLING OF EARLY COMPLIANCE WITH STAGE II

For engine types or engine families meeting the limit values set out in the table in section 4.2.2.2 of Annex I, before the dates laid down in point 4 of this Article, Member States shall allow special labelling and marking to show that the equipment concerned meets the required limit values before the dates laid down.

7. EXEMPTIONS

The following machinery shall be exempted from the implementation dates of stage II emission limit requirements for a period of three years after the entry into force of those emission limit requirements. For those three years, the stage I emission limit requirements shall continue to apply:

- hand-held chainsaw: a hand-held device designed to cut wood with a saw chain, designed to be supported with two hands and having an engine capacity in excess of 45 cm³, according to EN ISO 11681-1,
- top handle machine (i.e., hand-held drills and tree service chainsaws): a hand-held device with the handle on top of the machine designed to drill holes or to cut wood with a saw chain (according to ISO 11681-2),
- hand-held brush cutter with an internal combustion engine: a hand-held device with a rotating blade made of metal or plastic intended to cut weeds, brush, small trees and similar vegetation. It must be designed according to EN ISO 11806 to operate multi-positionally, such as horizontally or upside down, and have an engine capacity in excess of 40 cm³;
- hand-held hedge trimmer: a hand-held device designed for trimming hedges and bushes by means of one or more reciprocating cutter blades, according to EN 774,
- hand-held power cutter with an internal combustion engine: a hand-held device intended for cutting hard materials such as stone, asphalt, concrete or steel by means of a rotating metal blade with a displacement in excess of 50 cm³, according to EN 1454, and
- non-hand-held, horizontal shaft class SN:3 engine: only those class SN:3 non-hand-held engines with a horizontal shaft that produce power equal to or less than 2,5 kW and are used mainly for select, industrial purposes, including tillers, reel cutters, lawn aerators and generators.

8. OPTIONAL IMPLEMENTATION DELAY

Nevertheless, for each category, Member States may postpone the dates in paragraphs 3, 4 and 5 for two years in respect of engines with a production date prior to those dates.'

6. Article 10 is hereby amended as follows:

(a) paragraph 1 shall be replaced by the following:

'1. The requirements of Article 8(1) and (2), Article 9(4) and Article 9a (5) shall not apply to:

- engines for use by the armed services,
- engines exempted in accordance with paragraphs 1a and 2.;

(b) the following paragraph shall be inserted:

'1a. A replacement engine shall comply with the limit values that the engine to be replaced had to meet when originally placed on the market. The text "REPLACEMENT ENGINE" shall be attached to a label on the engine or inserted into the owner's manual.;

(c) the following paragraphs shall be added:

'3. The requirements of Article 9a(4) and (5) shall be postponed by three years for small volume engine manufacturers.

4. The requirements of Article 9a(4) and (5) shall be replaced by the corresponding stage I requirements for a small volume engine family to a maximum of 25 000 units providing that the various engine families involved all have different cylinder displacements.'

7. Articles 14 and 15 shall be replaced by the following Articles:

'Article 14

Adaptation to technical progress

Any amendments which are necessary in order to adapt the Annexes to this Directive, with the exception of the requirements specified in section 1, sections 2.1 to 2.8 and section 4 of Annex I, to take account of technical progress shall be adopted by the Commission in accordance with the procedure referred to in Article 15(2).

Article 14a

Procedure for derogations

The Commission shall study possible technical difficulties in complying with the stage II requirements for certain

<p>uses of the engines, in particular mobile machinery in which engines of classes SH:2 and SH:3 are installed. If the Commission studies conclude that for technical reasons certain mobile machinery, in particular, professional use, multi-positional, hand-held engines, cannot meet these deadlines, it shall submit, by 31 December 2003, a report accompanied by appropriate proposals for extensions of the period referred to in Article 9a(7) and/or further derogations, not exceeding five years, unless in exceptional circumstances, for such machinery, under the procedure laid down in Article 15(2).</p>	<p>ANNEX III</p>	<p>Test procedure for CI Engines</p>
	<p>Appendix 1</p>	<p>Measurement and sampling procedures</p>
	<p>Appendix 2</p>	<p>Calibration of the analytical instruments</p>
	<p>Appendix 3</p>	<p>Data evaluation and calculations</p>
	<p>ANNEX IV</p>	<p>Test procedure — Spark ignition engines</p>
<p><i>Article 15</i></p>	<p>Appendix 1</p>	<p>Measurement and sampling procedures</p>
<p>Committee</p>	<p>Appendix 2</p>	<p>Calibration of the analytical instruments</p>
<p>1. The Commission shall be assisted by the Committee on Adaptation to Technical Progress of the Directives on the Removal of Technical Barriers to Trade in the Motor Vehicle Sector (hereinafter referred to as "the Committee").</p>	<p>Appendix 3</p>	<p>Data evaluation and calculations</p>
<p>2. Where reference is made to this paragraph, Articles 5 and 7 of Decision 1999/468/EC (*) shall apply, having regard to the provisions of Article 8 thereof.</p>	<p>Appendix 4</p>	<p>Deterioration factors</p>
<p>The period laid down in Article 5(6) of Decision 1999/468/EC shall be set at three months.</p>	<p>ANNEX V</p>	<p>Technical characteristics of reference fuel prescribed for approval tests and to verify conformity of production Non-road mobile machinery reference fuel for CI engines</p>
<p>3. The Committee shall adopt its Rules of Procedure.</p>	<p>ANNEX VI</p>	<p>Analytical and sampling system</p>
<p>(*) OJ L 184, 17.7.1999, p. 23.'</p>	<p>ANNEX VII</p>	<p>Type approval certificate</p>
<p>8. The following list of Annexes shall be added at the beginning of the Annexes:</p>	<p>Appendix 1</p>	<p>Test result for CI engines</p>
<p>'List of Annexes</p>	<p>Appendix 2</p>	<p>Test result for SI engines</p>
<p>ANNEX I</p>	<p>Appendix 3</p>	<p>Equipment and auxiliaries to be installed for the test to determine engine power</p>
<p>Scope, definitions, symbols and abbreviations, engine markings, specifications and tests, specification of conformity of production assessments, parameters defining the engine family, choice of the parent engine</p>	<p>ANNEX VIII</p>	<p>Approval certificate numbering system</p>
<p>ANNEX II</p>	<p>ANNEX IX</p>	<p>List of engine/engine family type-approvals issued</p>
<p>Information documents</p>	<p>ANNEX X</p>	<p>List of engines produced</p>
<p>Appendix 1</p>	<p>ANNEX XI</p>	<p>Data sheet of type approved engines</p>
<p>Essential characteristics of the (parent) engine</p>	<p>ANNEX XII</p>	<p>Recognition of alternative type approvals'.</p>
<p>Appendix 2</p>		
<p>Essential characteristics of the engine family</p>		
<p>Appendix 3</p>		
<p>Essential characteristics of engine type within family</p>		
	<p>9. The Annexes shall be amended in accordance with the Annex to this Directive.</p>	

Article 2

1. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 11 August 2004. They shall forthwith inform the Commission thereof.

When Member States adopt these measures, they shall contain a reference to this Directive or shall be accompanied by such reference on the occasion of their official publication. The methods of making such reference shall be laid down by Member States.

2. Member States shall communicate to the Commission the text of the main provisions of the national law which they adopt in the field governed by this Directive.

Article 3

Not later than 11 August 2004, the Commission shall submit to the European Parliament and the Council a report and, if appropriate, a proposal regarding the potential costs, benefits and feasibility of:

- (a) reducing particulate emissions from small spark ignition engines with special attention to two stroke engines. The report shall take into account:
- (i) estimates of the contribution of such engines to the emission of particles, and the way proposed emission reduction measures could contribute towards improving air quality and reduced health effects;
 - (ii) tests, measurement procedures and equipment which could be used to assess particulate emissions from small spark ignition engines at type approval;

(iii) work and conclusion within the particulate measurement programme;

(iv) developments in test procedures, engine technology, exhaust purification as well as enhanced standards for fuel and engine oil; and

(v) costs of reducing particulate emissions from small spark ignition engines and the cost effectiveness of any proposed measures;

(b) reducing emissions from those recreational vehicles, including snowmobiles and go-carts, currently not covered;

(c) reducing exhaust gas and particulate emissions from small compression ignition engines under 18 Kw;

(d) reducing exhaust gas and particulate emissions from locomotive compression ignition engines. A test cycle should be formulated in order to measure such emissions.

Article 4

This Directive shall enter into force on the day of its publication in the *Official Journal of the European Union*.

Article 5

This Directive is addressed to the Member States.

Done at Brussels, 9 December 2002.

For the European Parliament

The President

P. COX

For the Council

The President

H. C. SCHMIDT

ANNEX

1. Annex I is hereby amended as follows:

(a) the first sentence of section 1 'SCOPE' shall be replaced by the following:

'This Directive applies to all engines to be installed in non-road mobile machinery and to secondary engines fitted into vehicles intended for passenger or goods transport on the road.'

(b) paragraphs 1 (A), (B), (C), (D) and (E) shall be amended as follows:

'A. intended and suited, to move, or to be moved on the ground, with or without road, and with either

(i) a CI engine having a net power in accordance with section 2.4 that is higher than 18 kW but not more than 560 kW ⁽⁴⁾ and that is operated under intermittent speed rather than a single constant speed.

Machinery, the engines

(remainder unchanged, down to

"— mobile cranes;");

or

(ii) a CI engine having a net power in accordance with section 2.4 that is higher than 18 kW but not more than 560 kW and that is operated under constant speed. Limits only apply from 31 December 2006.

Machinery, the engines of which are covered under this definition, includes but is not limited to:

- gas compressors,
- generating sets with intermittent load including refrigerating units and welding sets,
- water pumps,
- turf care, chippers, snow removal equipment, sweepers;

or

(iii) a petrol fuelled SI engine having a net power in accordance with section 2.4 of not more than 19 kW.

Machinery, the engines of which are covered under this definition, includes but is not limited to:

- lawn mowers,
- chain saws,
- generators,
- water pumps,
- bush cutters.

The Directive is not applicable for the following applications:

B. ships;

C. railway locomotives;

D. aircraft;

E. recreational vehicles, e.g.

- snow mobiles,
- off road motorcycles,
- all-terrain vehicles;';

(c) section 2 shall be amended as follows:

— the following words shall be added to footnote 2 in section 2.4:

‘... except for cooling fans of air cooled engines directly fitted on the crankshaft (see Appendix 3 of Annex VII).’;

— The following indent shall be added to section 2.8:

‘— for engines to be tested on cycle G1, the intermediate speed shall be 85 % of the maximum rated speed (see section 3.5.1.2 of Annex IV).’;

— the following sections shall be added:

‘2.9. adjustable parameter shall mean any physically adjustable device, system or element of design which may affect emission or engine performance during emission testing or normal operation;

2.10. after-treatment shall mean the passage of exhaust gases through a device or system whose purpose is chemically or physically to alter the gases prior to release to the atmosphere;

2.11. spark ignition (SI) engine shall mean an engine which works on the spark-ignition principle;

2.12. auxiliary emission control device shall mean any device that senses engine operation parameters for the purpose of adjusting the operation of any part of the emission control system;

2.13. emission control system shall mean any device, system or element of design which controls or reduces emissions;

2.14. fuel system shall mean all components involved in the metering and mixture of the fuel;

2.15. secondary engine shall mean an engine installed in or on a motor vehicle, but not providing motive power to the vehicle;

2.16. mode length means the time between leaving the speed and/or torque of the previous mode or the preconditioning phase and the beginning of the following mode. It includes the time during which speed and/or torque are changed and the stabilisation at the beginning of each mode.’;

— section 2.9 shall become section 2.17 and current sections 2.9.1 to 2.9.3 shall become sections 2.17.1 to 2.17.3.

(d) section 3 shall be amended as follows:

— section 3.1 shall be replaced by the following:

‘3.1. Compression ignition engines approved in accordance with this Directive must bear.’;

— section 3.1.3 shall be amended as follows:

‘Annex VII’ shall be replaced by ‘Annex VIII’,

— the following section shall be inserted:

‘3.2. Spark-ignition engines approved in accordance with this Directive must bear:

3.2.1. the trade mark or trade name of the manufacturer of the engine;

3.2.2. the EC type-approval number as defined in Annex VIII.’;

— sections 3.2 to 3.6 shall become sections 3.3 to 3.7,

— section 3.7 shall be amended as follows: ‘Annex VI’ shall be replaced by ‘Annex VII’;

(e) section 4 shall be amended as follows:

- the following heading shall be inserted: '4.1 CI engines.';
- current section 4.1 shall become section 4.1.1 and the reference to section 4.2.1 and 4.2.3. shall be replaced by a reference to section 4.1.2.1 and 4.1.2.3,
- current section 4.2 shall become section 4.1.2 and shall be amended as follows: 'Annex V' shall be replaced throughout by 'Annex VI',
- current section 4.2.1 shall become section 4.1.2.1; current section 4.2.2 shall become section 4.1.2.2 and the reference to section 4.2.1 shall be replaced by a reference to section 4.1.2.1; current sections 4.2.3 and 4.2.4 shall become sections 4.1.2.3 and 4.1.2.4;

(f) the following paragraph shall be added:

4.2. SI engines

4.2.1. General

The components liable to affect the emission of gaseous pollutants shall be so designed, constructed and assembled as to enable the engine, in normal use, despite the vibrations to which it may be subjected, to comply with the provisions of this Directive.

The technical measures taken by the manufacturer must be such as to ensure that the mentioned emissions are effectively limited, pursuant to this Directive, throughout the normal life of the engine and under normal conditions of use in accordance with Annex IV, Appendix 4.

4.2.2. Specifications concerning the emissions of pollutants.

The gaseous components emitted by the engine submitted for testing shall be measured by the methods described in Annex VI (and shall include any after-treatment device).

Other systems or analysers may be accepted if they yield equivalent results to the following reference systems:

- for gaseous emissions measured in the raw exhaust, the system shown in Figure 2 of Annex VI,
- for gaseous emissions measured in the dilute exhaust of a full flow dilution system, the system shown in figure 3 of Annex VI.

4.2.2.1. The emissions of carbon monoxide, the emissions of hydrocarbons, the emissions of oxides of nitrogen and the sum of hydrocarbons and oxides of nitrogen obtained shall for stage I not exceed the amount shown in the table below:

Stage I

Class	Carbon monoxide (CO) (g/kWh)	Hydrocarbons (HC) (g/kWh)	Oxides of nitrogen (NO _x) (g/kWh)	Sum of hydrocarbons and oxides of nitrogen (g/kWh)
				HC + NO _x
SH:1	805	295	5,36	
SH:2	805	241	5,36	
SH:3	603	161	5,36	
SN:1	519			50
SN:2	519			40
SN:3	519			16,1
SN:4	519			13,4

- 4.2.2.2. The emissions of carbon monoxide and the emissions of the sum of hydrocarbons and oxides of nitrogen obtained shall for stage II not exceed the amount shown in the table below:

Stage II (*)

Class	Carbon monoxide (CO) (g/kWh)	Sum of hydrocarbons and oxides of nitrogen (g/kWh)
		HC + NO _x
SH:1	805	50
SH:2	805	50
SH:3	603	72
SN:1	610	50,0
SN:2	610	40,0
SN:3	610	16,1
SN:4	610	12,1

The NO_x emissions for all engine classes must not exceed 10 g/kWh.

- 4.2.2.3. Notwithstanding the definition of "hand-held engine" in Article 2 of this Directive two-stroke engines used to power snowthrowers only have to meet SH:1, SH:2 or SH:3 standards.

(*) See Annex 4, Appendix 4: deterioration factors included.;

- (g) sections 6.3 to 6.9 shall be replaced by the following sections:

'6.3. Individual cylinder displacement, within 85 % and 100 % of the largest displacement within the engine family

6.4. Method of air aspiration

6.5. Fuel type

- Diesel
- Petrol.

6.6. Combustion chamber type/design

6.7. Valve and porting — configurations, size and number

6.8. Fuel system

For diesel:

- pump-line injector
- in-line pump
- distributor pump
- single element
- unit injector.

For petrol:

- carburettor
- port fuel injection
- direct injection.

6.9. Miscellaneous features

- Exhaust gas recirculation
- Water injection/emulsion
- Air injection
- Charge cooling system
- Ignition type (compression, spark).

6.10. Exhaust after-treatment

- Oxidation catalyst
- Reduction catalyst
- Three way catalyst
- Thermal reactor
- Particulate trap'.

2. Annex II is hereby amended as follows:

(a) in Appendix 2 the text in the table shall be amended as follows:

'Fuel delivery per stroke (mm³)' in lines 3 and 6 shall be replaced by 'Fuel delivery per stroke (mm³) for diesel engines, fuel flow (g/h) for petrol engines';

(b) appendix 3 shall be amended as follows:

— the heading of section 3 shall be replaced by 'FUEL FEED FOR DIESEL ENGINES'

— The following sections shall be inserted:

'4. FUEL FEED FOR PETROL ENGINES

4.1. Carburettor:

4.1.1. Make(s):

4.1.2. Type(s):

4.2. Port fuel injection: single-point or multi-point:

4.2.1. Make(s):

4.2.2. Type(s)

4.3. Direct injection:

4.3.1. Make(s):

4.3.2. Type(s):

4.4. Fuel flow [g/h] and air/fuel ratio at rated speed and wide open throttle';

— current section 4 shall become section 5 and the following points shall be added:

'5.3. Variable valve timing system (if applicable and where intake and/or exhaust)

5.3.1. Type: continuous or on/off

5.3.2. Cam phase shift angle';

— the following sections shall be added:

'6. PORTING CONFIGURATION

6.1. Position, size and number'

7. IGNITION SYSTEM
- 7.1. Ignition coil
- 7.1.1. Make(s):
- 7.1.2. Type(s):
- 7.1.3. Number:
- 7.2. Spark plug(s):
- 7.2.1. Make(s):
- 7.2.2. Type(s):
- 7.3. Magneto:
- 7.3.1. Make(s):
- 7.3.2. Type(s):
- 7.4. Ignition timing:
- 7.4.1. Static advance with respect to top dead centre [crank angle degrees]
- 7.4.2. Advance curve, if applicable:

3. Annex III shall be amended as follows:

- (a) the heading shall be replaced by the following:

'TEST PROCEDURE FOR C.I. ENGINES';

- (b) section 2.7 shall be amended as follows:

'Annex VI' shall be replaced by 'Annex VII' and 'Annex IV' shall be replaced by 'Annex V';

- (c) section 3.6 shall be amended as follows:

— sections 3.6.1 and 3.6.1.1 shall be amended as follows:

'3.6.1. Equipment specifications according to section 1(A) of Annex I:

3.6.1.1. Specification A: For engines covered by Section 1(A)(i) of Annex I, the following eight-mode cycle (*) shall be followed in dynamometer operation on the test engine: (table unchanged).

(*) Identical with C1 cycle of the draft ISO 8178-4 standard.'

— the following section shall be added:

'3.6.1.2. Specification B. For engines covered by Sections 1(A)(ii), the following five-mode cycle ⁽¹⁾ shall be followed in dynamometer operation on the test engine:

Mode number	Engine speed	Load %	Weighting factor
1	Rated	100	0,05
2	Rated	75	0,25
3	Rated	50	0,3
4	Rated	25	0,3
5	Rated	10	0,1

The load figures are percentage values of the torque corresponding to the prime power rating defined as the maximum power available during a variable power sequence, which may be run for an unlimited number of hours per year, between stated maintenance intervals and under the stated ambient conditions, the maintenance being carried out as prescribed by the manufacturer. ⁽²⁾.

⁽¹⁾ Identical with D2 cycle of the ISO 8178-4: 1996(E) standard.

⁽²⁾ For a better illustration of the prime power definition, see figure 2 of ISO 8528-1: 1993(E) standard.'

— section 3.6.3 shall be amended as follows:

'3.6.3. Test sequence

The test sequence shall be started. The test shall be performed in ascending order of mode numbers as set out above for the test cycles.

During each mode of the given test cycle' (remainder unchanged);

(d) appendix 1, section 1 shall be amended as follows:

In section 1 and 1.4.3, 'Annex V' shall be replaced by 'Annex VI' throughout.

4. The following Annex shall be added:

'ANNEX IV

TEST PROCEDURE FOR SPARK IGNITION ENGINES

1. INTRODUCTION

1.1. This Annex describes the method of determining emissions of gaseous pollutants from the engines to be tested.

1.2. The test shall be carried out with the engine mounted on a test bench and connected to a dynamometer.

2. TEST CONDITIONS

2.1. **Engine test conditions**

The absolute temperature (T_a) of the engine air at the inlet to the engine, expressed in Kelvin, and the dry atmospheric pressure (p_s), expressed in kPa, shall be measured and the parameter f_a shall be determined according to the following provisions:

$$f_a = \left(\frac{99}{p_s}\right)^{1,2} \times \left(\frac{T_a}{298}\right)^{0,6}$$

2.1.1. *Test validity*

For a test to be recognised as valid, the parameter f_a shall be such that:

$$0,93 \leq f_a \leq 1,07$$

2.1.2. *Engines with charge air-cooling*

The temperature of the cooling medium and the temperature of the charge air have to be recorded.

2.2. **Engine air inlet system**

The test engine shall be equipped with an air inlet system presenting an air inlet restriction within 10 % of the upper limit specified by the manufacturer for a new air cleaner at the engine operating conditions, as specified by the manufacturer, which result in maximum air flow in the respective engine application.

For small spark ignition engines (< 1 000 cm³ displacement) a system representative of the installed engine shall be used.

2.3. Engine exhaust system

The test engine shall be equipped with an exhaust system presenting an exhaust back pressure within 10 % of the upper limit specified by the manufacturer for the engine operating conditions which result in the maximum declared power in the respective engine application.

For small spark ignition engines (< 1 000 cm³ displacement) a system representative of the installed engine shall be used.

2.4. Cooling system

An engine cooling system with sufficient capacity to maintain the engine at normal operating temperatures prescribed by the manufacturer shall be used. This provision shall apply to units which have to be detached in order to measure the power, such as with a blower where the blower (cooling) fan has to be disassembled to get access to the crankshaft.

2.5. Lubricating oil

Lubricating oil that meets the engine manufacturer's specifications for a particular engine and intended usage shall be used. Manufacturers must use engine lubricants representative of commercially available engine lubricants.

The specifications of the lubricating oil used for the test shall be recorded at section 1.2 of Annex VII, Appendix 2, for SI engines and presented with the results of the test.

2.6. Adjustable carburettors

Engines with limited adjustable carburettors shall be tested at both extremes of the adjustment.

2.7. Test fuel

The fuel shall be the reference fuel specified in Annex V.

The octane number and the density of the reference fuel used for test shall be recorded at section 1.1.1 of Annex VII, Appendix 2, for SI engines.

For two-stroke engines, the fuel/oil mixture ratio must be the ratio which shall be recommended by the manufacturer. The percentage of oil in the fuel/lubricant mixture feeding the two-stroke engines and the resulting density of the fuel shall be recorded at section 1.1.4 of Annex VII, Appendix 2, for SI engines.

2.8. Determination of dynamometer settings

Emissions measurements shall be based on uncorrected brake power. Auxiliaries necessary only for the operation of the machine and which may be mounted on the engine shall be removed for the test. Where auxiliaries have not been removed, the power absorbed by them shall be determined in order to calculate the dynamometer settings except for engines where such auxiliaries form an integral part of the engine (e.g. cooling fans for air cooled engines).

The settings of inlet restriction and exhaust pipe backpressure shall be adjusted, for engines where it shall be possible to perform such an adjustment, to the manufacturer's upper limits, in accordance with sections 2.2 and 2.3. The maximum torque values at the specified test speeds shall be determined by experimentation in order to calculate the torque values for the specified test modes. For engines which are not designed to operate over a speed range on a full load torque curve, the maximum torque at the test speeds shall be declared by the manufacturer. The engine setting for each test mode shall be calculated using the formula:

$$S = \left((P_M + P_{AE}) \times \frac{L}{100} \right) - P_{AE}$$

where:

S is the dynamometer setting [kW],

P_M is the maximum observed or declared power at the test speed under the test conditions (see Appendix 2 of Annex VII) [kW],

P_{AE} is the declared total power absorbed by any auxiliary fitted for the test [kW] and not required by Appendix 3 of Annex VII,

L is the percent torque specified for the test mode.

If the ratio

$$\frac{P_{AE}}{P_M} \geq 0,03$$

the value of P_{AE} may be verified by the technical authority granting type-approval.

3. TEST RUN

3.1. Installation of the measuring equipment

The instrumentation and sampling probes shall be installed as required. When using a full flow dilution system for exhaust gas dilution, the tailpipe shall be connected to the system.

3.2. Starting the dilution system and engine

The dilution system and the engine shall be started and warmed up until all temperatures and pressures have stabilised at full load and rated speed (section 3.5.2).

3.3. Adjustment of the dilution ratio

The total dilution ratio shall not be less than four.

For CO₂ or NO_x concentration controlled systems, the CO₂ or NO_x content of the dilution air must be measured at the beginning and at the end of each test. The pre- and post-test background CO₂ or NO_x concentration measurements of the dilution air must be within 100 ppm or 5 ppm of each other, respectively.

When using a dilute exhaust gas analysis system, the relevant background concentrations shall be determined by sampling dilution air into a sampling bag over the complete test sequence.

Continuous (non-bag) background concentration may be taken at the minimum of three points, at the beginning, at the end, and a point near the middle of the cycle and averaged. At the manufacturer's request background measurements may be omitted.

3.4. Checking the analysers

The emission analysers shall be set at zero and spanned.

3.5. Test cycle

3.5.1. Specification (c) of machinery according to section 1A(iii) of Annex I.

The following test cycles shall be followed in dynamometer operation on the test engine according to the given type of machinery:

cycle D ⁽¹⁾: engines with constant speed and intermittent load such as generating sets;

cycle G1: non-hand-held intermediate speed applications;

cycle G2: non-hand-held rated speed applications;

cycle G3: hand-held applications.

⁽¹⁾ Identical with D2 cycle of the ISO 8168-4: 1996(E) standard.

3.5.1.1. Test modes and weighting factors

Cycle D											
Mode number	1	2	3	4	5						
Engine speed	Rated speed					Intermediate					Low-idle speed
Load (l) %	100	75	50	25	10						
Weighting factor	0,05	0,25	0,3	0,3	0,1						

Cycle G1											
Mode number						1	2	3	4	5	6
Engine speed	Rated speed					Intermediate Speed					Low-idle speed
Load %						100	75	50	25	10	0
Weighting factor						0,09	0,2	0,29	0,3	0,07	0,05

Cycle G2											
Mode number	1	2	3	4	5						6
Engine speed	Rated speed					Intermediate Speed					Low-idle speed
Load %	100	75	50	25	10						0
Weighting factor	0,09	0,2	0,29	0,3	0,07						0,05

Cycle G3											
Mode number	1										2
Engine speed	Rated speed					Intermediate Speed					Low-idle speed
Load %	100										0
Weighting factor	0,85 (*)										0,15 (*)

(l) The load figures are percentage values of the torque corresponding to the prime power rating defined as the maximum power available during a variable power sequence, which may be run for an unlimited number of hours per year, between stated maintenance intervals and under the stated ambient conditions, the maintenance being carried out as prescribed by the manufacturer. For a better illustration of the prime power definition, see figure 2 of ISO 8528-1: 1993(E) standard.

(*) For stage I, 0,90 and 0,10 may be used instead of 0,85 and 0,15 respectively.

3.5.1.2. Choosing an appropriate test cycle

If the primary end use of an engine model is known then the test cycle may be chosen based on the examples given in section 3.5.1.3. If the primary end use of an engine is uncertain then the appropriate test cycle should be chosen based upon the engine specification.

3.5.1.3. Examples (the list is not exhaustive)

Typical examples are for:

cycle D:

generating sets with intermittent load including generating sets on board ships and trains (not for propulsion), refrigerating units, welding sets;

gas compressors;

cycle G1:

front or rear engines riding lawn mowers;

golf carts;

lawn sweepers;

pedestrian-controlled rotary or cylinder lawn mowers;

snow-removal equipment;

waste disposers;

cycle G2:

portable generators, pumps, welders and air compressors;

may also include lawn and garden equipment, which operate at engine rated speed;

cycle G3:

blowers;

chain saws;

hedge trimmers;

portable saw mills;

rotary tillers;

sprayers;

string trimmers;

vacuum equipment.

3.5.2. *Conditioning of the engine*

Warming up of the engine and the system shall be at maximum speed and torque in order to stabilise the engine parameters according to the recommendations of the manufacturer.

Note: The conditioning period should also prevent the influence of deposits from a former test in the exhaust system. There is also a required period of stabilisation between test points which has been included to minimise point to point influences.

3.5.3. *Test sequence*

Test cycles G1, G2 or G3 shall be performed in ascending order of mode number of the cycle in question. Each mode sampling time shall be at least 180 s. The exhaust emission concentration values shall be measured and recorded for the last 120 s of the respective sampling time. For each measuring point, the mode length shall be of sufficient duration to achieve thermal stability of the engine prior to the start of sampling. The mode length shall be recorded and reported.

- (a) For engines tested with the dynamometer speed control test configuration: During each mode of the test cycle after the initial transition period, the specified speed shall be held to within $\pm 1\%$ of rated speed or $\pm 3 \text{ min}^{-1}$ whichever is greater except for low idle which shall be within the tolerances declared by the manufacturer. The specified torque shall be held so that the average over the period during which the measurements are being taken is within $\pm 2\%$ of the maximum torque at the test speed.
- (b) For engines tested with the dynamometer load control test configuration: During each mode of the test cycle after the initial transition period, the specified speed shall be within $\pm 2\%$ of rated speed or $\pm 3 \text{ min}^{-1}$ whichever is greater, but shall in any case be held within $\pm 5\%$, except for low idle which shall be within the tolerances declared by the manufacturer.

During each mode of the test cycle where the prescribed torque is 50 % or greater of the maximum torque at the test speed the specified average torque over the data acquisition period shall be held within $\pm 5\%$ of the prescribed torque. During modes of the test cycle where the prescribed torque is less than 50 % of the maximum torque at the test speed the specified average torque over the data acquisition period shall be held within $\pm 10\%$ of the prescribed torque or $\pm 0,5 \text{ Nm}$ whichever is greater.

3.5.4. *Analyser response*

The output of the analysers shall be recorded on a strip chart recorder or measured with an equivalent data acquisition system with the exhaust gas flowing through the analysers at least during the last 180 s of each mode. If bag sampling is applied for the diluted CO and CO₂ measurement (see Appendix 1, section 1.4.4), a sample shall be bagged during the last 180 s of each mode, and the bag sample analysed and recorded.

3.5.5. *Engine conditions*

The engine speed and load, intake air temperature and fuel flow shall be measured for each mode once the engine has been stabilised. Any additional data required for calculation shall be recorded (see Appendix 3, sections 1.1 and 1.2).

3.6. **Rechecking the analysers**

After the emission test a zero gas and the same span gas shall be used for re-checking. The test shall be considered acceptable if the difference between the two measuring results is less than 2 %.

Appendix 1

1. MEASUREMENT AND SAMPLING PROCEDURES

Gaseous components emitted by the engine submitted for testing shall be measured by the methods described in Annex VI. The methods of Annex VI describe the recommended analytical systems for the gaseous emissions (section 1.1).

1.1. **Dynamometer specification**

An engine dynamometer with adequate characteristics to perform the test cycles described in Annex IV, section 3.5.1 shall be used. The instrumentation for torque and speed measurement shall allow the measurement of the shaft power within the given limits. Additional calculations may be necessary.

The accuracy of the measuring equipment must be such that the maximum tolerances of the figures given in section 1.3 are not exceeded.

1.2. Fuel flow and total diluted flow

Fuel flow meters with the accuracy defined in section 1.3 shall be used to measure the fuel flow that will be used to calculate emissions (Appendix 3). When using a full flow dilution system, the total flow of the dilute exhaust (G_{TOTW}) shall be measured with a PDP or CFV — Annex VI, section 1.2.1.2. The accuracy shall conform to the provisions of Annex III, Appendix 2, section 2.2.

1.3. Accuracy

The calibration of all measuring instruments shall be traceable to national (international) standards and comply with the requirements given in tables 2 and 3.

Table 2 — Permissible deviations of instruments for engine related parameters

No	Item	Permissible deviation
1	Engine speed	$\pm 2\%$ of the reading or $\pm 1\%$ of engine's max value whichever is larger
2	Torque	$\pm 2\%$ of the reading or $\pm 1\%$ of engine's max value whichever is larger
3	Fuel consumption ^(a)	$\pm 2\%$ of engine's max value
4	Air consumption ^(a)	$\pm 2\%$ of the reading or $\pm 1\%$ of engine's max value whichever is larger

^(a) The calculations of the exhaust emissions as described in this Directive are, in some cases, based on different measurement and/or calculation methods. Because of limited total tolerances for the exhaust emission calculation, the allowable values for some items, used in the appropriate equations, must be smaller than the allowed tolerances given in ISO 3046-3.

Table 3 — Permissible deviations of instruments for other essential parameters

No	Item	Permissible deviation
1	Temperatures ≤ 600 K	± 2 K absolute
2	Temperatures ≥ 600 K	$\pm 1\%$ of reading
3	Exhaust gas pressure	$\pm 0,2$ kPa absolute
4	Inlet manifold depressions	$\pm 0,05$ kPa absolute
5	Atmospheric pressure	$\pm 0,1$ kPa absolute
6	Other pressures	$\pm 0,1$ kPa absolute
7	Relative humidity	$\pm 3\%$ absolute
8	Absolute humidity	$\pm 5\%$ of reading
9	Dilution air flow	$\pm 2\%$ of reading
10	Diluted exhaust gas flow	$\pm 2\%$ of reading

1.4. Determination of the gaseous components

1.4.1. General analyser specifications

The analysers shall have a measuring range appropriate for the accuracy required for measuring the concentrations of the exhaust gas components (section 1.4.1.1). It is recommended that the analysers be operated such that the measured concentration falls between 15 % and 100 % of full scale.

If the full scale value is 155 ppm (or ppm C) or less or if read-out systems (computers, data loggers) that provide sufficient accuracy and resolution below 15 % of full scale are used concentrations below 15 % of full scale are also acceptable. In this case, additional calibrations are to be made to ensure the accuracy of the calibration curves — Appendix 2, section 1.5.5.2, of this Annex.

The electromagnetic compatibility (EMC) of the equipment shall be on a level as to minimise additional errors.

1.4.1.1. Accuracy

The analyser shall not deviate from the nominal calibration point by more than $\pm 2\%$ of the reading over the whole measurement range except zero, and $\pm 0,3\%$ of full scale at zero. The accuracy shall be determined according to the calibration requirements laid down in section 1.3.

1.4.1.2. Repeatability

The repeatability, shall be such that 2,5 times the standard deviation of 10 repetitive responses to a given calibration or span gas is not greater than $\pm 1\%$ of full scale concentration for each range used above 100 ppm (or ppmC) or $\pm 2\%$ of each range used below 100 ppm (or ppmC).

1.4.1.3. Noise

The analyser peak-to-peak response to zero and calibration or span gases over any 10-s period shall not exceed 2 % of full scale on all ranges used.

1.4.1.4. Zero drift

Zero response is defined as the mean response, including noise, to a zero gas during a 30-s time interval. The drift of the zero response during a one-hour period shall be less than 2 % of full scale on the lowest range used.

1.4.1.5. Span drift

Span response is defined as the mean response, including noise, to a span gas during a 30-s time interval. The drift of the span response during a one-hour period shall be less than 2 % of full scale on the lowest range used.

1.4.2. Gas drying

Exhaust gases may be measured wet or dry. Any gas-drying device, if used, must have a minimal effect on the concentration of the measured gases. Chemical dryers are not an acceptable method of removing water from the sample.

1.4.3. Analysers

Sections 1.4.3.1 to 1.4.3.5 describe the measurement principles to be used. A detailed description of the measurement systems is given in Annex VI.

The gases to be measured shall be analysed with the following instruments. For non-linear analysers, the use of linearising circuits is permitted.

1.4.3.1. Carbon monoxide (CO) analysis

The carbon monoxide analyser shall be of the non-dispersive infrared (NDIR) absorption type.

1.4.3.2. Carbon dioxide (CO₂) analysis

The carbon dioxide analyser shall be of the non-dispersive infrared (NDIR) absorption type.

1.4.3.3. Oxygen (O₂) analysis

Oxygen analysers shall be of the paramagnetic detector (PMD), zirconium dioxide (ZRDO) or electrochemical sensor (ECS) types.

Note: Zirconium dioxide sensors are not recommended when HC and CO concentrations are high such as for lean burn spark ignited engines. Electrochemical sensors shall be compensated for CO₂ and NO_x interference.

1.4.3.4. Hydrocarbon (HC) analysis

For direct gas sampling the hydrocarbon analyser shall be of the heated flame ionisation detector (HFID) type with detector, valves, pipework, etc., heated so as to maintain a gas temperature of 463 K ± 10 K (190 °C ± 10 °C).

For diluted gas sampling the hydrocarbon analyser shall be either the heated flame ionisation detector (HFID) type or the flame ionisation detector (FID) type.

1.4.3.5. Oxides of nitrogen (NO_x) analysis

The oxides of nitrogen analyser shall be of the chemiluminescent detector (CLD) or heated chemiluminescent detector (HCLD) type with a NO₂/NO converter, if measured on a dry basis. If measured on a wet basis, a HCLD with converter maintained above 328 K (55 °C) shall be used, provided the water quench check (Annex III, Appendix 2, section 1.9.2.2) is satisfied. For both CLD and HCLD, the sampling path shall be maintained at a wall temperature of 328 K to 473 K (55 °C to 200 °C) up to the converter for dry measurement, and up to the analyser for wet measurement.

1.4.4. *Sampling for gaseous emissions*

If the composition of the exhaust gas is influenced by any exhaust after-treatment system, the exhaust sample shall be taken downstream of this device.

The exhaust sampling probe should be in a high pressure side of the muffler, but as far from the exhaust port as possible. To ensure complete mixing of the engine exhaust before sample extraction, a mixing chamber may be optionally inserted between the muffler outlet and the sample probe. The internal volume of the mixing chamber must be not less than 10 times the cylinder displacement of the engine under test and should be roughly equal dimensions in height, width and depth, being similar to a cube. The mixing chamber size should be kept as small as practicable and should be coupled as close as possible to the engine. The exhaust line leaving the mixing chamber of muffler should extend at least 610 mm beyond the sample probe location and be of sufficient size to minimise back pressure. The temperature of the inner surface of the mixing chamber must be maintained above the dew point of the exhaust gases and a minimum temperature of 338 °K (65 °C) is recommended.

All components may optionally be measured directly in the dilution tunnel, or by sampling into a bag and subsequent measurement of the concentration in the sampling bag.

Appendix 2

1. CALIBRATION OF THE ANALYTICAL INSTRUMENTS

1.1. **Introduction**

Each analyser shall be calibrated as often as necessary to fulfil the accuracy requirements of this standard. The calibration method that shall be used is described in this paragraph for the analysers indicated in Appendix 1, section 1.4.3.

1.2. **Calibration gases**

The shelf life of all calibration gases must be respected.

The expiry date of the calibration gases stated by the manufacturer shall be recorded.

1.2.1 *Pure gases*

The required purity of the gases is defined by the contamination limits given below. The following gases must be available for operation:

- purified nitrogen (contamination ≤ 1 ppm C, ≤ 1 ppm CO, ≤ 400 ppm CO₂, $\leq 0,1$ ppm NO),
- purified oxygen (purity $> 99,5$ Vol.- % O₂),
- hydrogen-helium mixture (40 ± 2 % hydrogen, balance helium); contamination ≤ 1 ppm C, ≤ 400 ppm CO₂,
- purified synthetic air (contamination ≤ 1 ppm C, ≤ 1 ppm CO, ≤ 400 ppm CO₂, $\leq 0,1$ ppm NO (oxygen content between 18 % and 21 % vol).

1.2.2 *Calibration and span gases*

Mixture of gases having the following chemical compositions shall be available:

- C₃H₈ and purified synthetic air (see section 1.2.1),
- CO and purified nitrogen,
- and purified nitrogen (the amount of NO₂ contained in this calibration gas must not exceed 5 % of the NO content),
- CO₂ and purified nitrogen,
- CH₄ and purified synthetic air,
- C₂H₆ and purified synthetic air.

Note: Other gas combinations are allowed provided the gases do not react with one another.

The true concentration of a calibration and span gas shall be within ± 2 % of the nominal value. All concentrations of calibration gas shall be given on a volume basis (volume percent or volume ppm).

The gases used for calibration and span may also be obtained by means of precision blending devices (gas dividers), diluting with purified N₂ or with purified synthetic air. The accuracy of the mixing device must be such that the concentration of the diluted calibration gases is accurate to within $\pm 1,5$ %. This accuracy implies that primary gases used for blending must be known to an accuracy of at least ± 1 %, traceable to national or international gas standards. The verification shall be performed at between 15 % and 50 % of full scale for each calibration incorporating a blending device.

Optionally, the blending device may be checked with an instrument, which by nature is linear, e.g. using NO gas with a CLD. The span value of the instrument shall be adjusted with the span gas directly connected to the instrument. The blending device shall be checked at the used settings and the nominal value shall be compared to the measured concentration of the instrument. This difference shall in each point be within $\pm 0,5$ % of the nominal value.

1.2.3 *Oxygen interference check*

Oxygen interference check gases shall contain propane with 350 ppm C \pm 75 ppm C hydrocarbon. The concentration value shall be determined to calibration gas tolerances by chromatographic analysis of total hydrocarbons plus impurities or by dynamic blending. Nitrogen shall be the predominant diluent with the balance oxygen. Blend required for gasoline-fuelled engine testing is as follows:

O ₂ interference concentration	Balance
10 (9 to 11)	Nitrogen
5 (4 to 6)	Nitrogen
0 (0 to 1)	Nitrogen.

1.3. **Operating procedure for analysers and sampling system**

The operating procedure for analysers shall follow the start-up and operating instructions of the instrument manufacturer. The minimum requirements given in sections 1.4 to 1.9 shall be included. For laboratory instruments such as GC and high performance liquid chromatography (HPLC) only section 1.5.4 shall apply.

1.4. **Leakage test**

A system leakage test shall be performed. The probe shall be disconnected from the exhaust system and the end plugged. The analyser pump shall be switched on. After an initial stabilisation period all flow meters should read zero. If not, the sampling lines shall be checked and the fault corrected.

The maximum allowable leakage rate on the vacuum side shall be 0,5 % of the in-use flow rate for the portion of the system being checked. The analyser flows and bypass flows may be used to estimate the in-use flow rates.

Alternatively, the system may be evacuated to a pressure of at least 20 kPa vacuum (80 kPa absolute). After an initial stabilisation period the pressure increase δp (kPa/min) in the system shall not exceed:

$$\delta p = p/V_{\text{sys}} \times 0,005 \times fr$$

Where:

V_{sys} = system volume [l]

fr = system flow rate [l/min]

Another method is the introduction of a concentration step change at the beginning of the sampling line by switching from zero to span gas. If after an adequate period of time the reading shows a lower concentration compared to the introduced concentration, this points to calibration or leakage problems.

1.5. **Calibration procedure**

1.5.1 *Instrument assembly*

The instrument assembly shall be calibrated and calibration curves checked against standard gases. The same gas flow rates shall be used as when sampling exhaust gas.

1.5.2 *Warming-up time*

The warming-up time should be according to the recommendations of the manufacturer. If not specified, a minimum of two hours is recommended for warming-up the analysers.

1.5.3 *NDIR and HFID analyser*

The NDIR analyser shall be tuned, as necessary, and the combustion flame of the HFID analyser shall be optimised (section 1.9.1).

1.5.4 *GC and HPCL*

Both instruments shall be calibrated according to good laboratory practice and the recommendations of the manufacturer.

1.5.5 *Establishment of the calibration curves*

1.5.5.1 *General guidelines*

- (a) Each normally used operating range shall be calibrated.
- (b) Using purified synthetic air (or nitrogen), the CO, CO₂, NO_x and HC analysers shall be set at zero.

- (c) The appropriate calibration gases shall be introduced to the analysers, the values recorded, and the calibration curves established.
- (d) For all instrument ranges except for the lowest range, the calibration curve shall be established by at least 10 calibration points (excluding zero) equally spaced. For the lowest range of the instrument, the calibration curve shall be established by at least 10 calibration points (excluding zero) spaced so that half of the calibration points are placed below 15 % of the analyser's full scale and the rest are placed above 15 % of full scale. For all ranges the highest nominal concentration must be equal to or higher than 90 % of full scale.
- (e) The calibration curve shall be calculated by the method of least squares. A best-fit linear or non-linear equation may be used.
- (f) The calibration points must not differ from the least-squares best-fit line by more than $\pm 2\%$ of reading or $\pm 0,3\%$ of full scale whichever is larger.
- (g) The zero setting shall be rechecked and the calibration procedure repeated, if necessary.

1.5.5.2. Alternative methods

If it can be shown that alternative technology (e.g. computer, electronically controlled range switch, etc.) can give equivalent accuracy, then these alternatives may be used.

1.6. Verification of the calibration

Each normally used operating range shall be checked prior to each analysis in accordance with the following procedure.

The calibration is checked by using a zero gas and a span gas whose nominal value is more than 80 % of full scale of the measuring range.

If, for the two points considered, the value found does not differ by more than $\pm 4\%$ of full scale from the declared reference value, the adjustment parameters may be modified. Should this not be the case, the span gas shall be verified or a new calibration curve shall be established in accordance with section 1.5.5.1.

1.7. Calibration of tracer gas analyser for exhaust flow measurement

The analyser for measurement of the tracer gas concentration shall be calibrated using the standard gas.

The calibration curve shall be established by at least 10 calibration points (excluding zero) spaced so that half of the calibration points are placed between 4 % to 20 % of the analyser's full scale and the rest are in between 20 % and 100 % of the full scale. The calibration curve shall be calculated by the method of least squares.

The calibration curve must not differ by more than $\pm 1\%$ of the full scale from the nominal value of each calibration point, in the range from 20 % to 100 % of the full scale. It also must not differ by more than $\pm 2\%$ of reading from the nominal value in the range from 4 % to 20 % of the full scale. The analyser shall be set at zero and spanned prior to the test run using a zero gas and a span gas whose nominal value is more than 80 % of the analyser full scale.

1.8. Efficiency test of the NO_x converter

The efficiency of the converter used for the conversion of NO₂ into NO is tested as given in sections 1.8.1 to 1.8.8 (figure 1 of Annex III, Appendix 2).

1.8.1. Test set-up

Using the test set-up as shown in figure 1 of Annex III and the procedure below, the efficiency of converters can be tested by means of an ozonator.

1.8.2. Calibration

The CLD and the HCLD shall be calibrated in the most common operating range following the manufacturer's specifications using zero and span gas (the NO content of which must amount to about 80 % of the operating range and the NO₂ concentration of the gas mixture to less than 5 % of the NO concentration). The NO_x analyser must be in the NO mode so that the span gas does not pass through the converter. The indicated concentration has to be recorded.

1.8.3. Calculation

The efficiency of the NO_x converter is calculated as follows:

$$\text{Efficiency (\%)} = \left(1 + \frac{a - b}{c - d}\right) \times 100$$

Where:

a = NO_x concentration according to section 1.8.6

b = NO_x concentration according to section 1.8.7

c = NO concentration according to section 1.8.4

d = NO concentration according to section 1.8.5.

1.8.4. Adding of oxygen

Via a T-fitting, oxygen or zero air is added continuously to the gas flow until the concentration indicated is about 20 % less than the indicated calibration concentration given in section 1.8.2. (The analyser is in the NO mode.)

The indicated concentration (c) shall be recorded. The ozonator is kept deactivated throughout the process.

1.8.5. Activation of the ozonator

The ozonator is now activated to generate enough ozone to bring the NO concentration down to about 20 % (minimum 10 %) of the calibration concentration given in section 1.8.2. The indicated concentration (d) shall be recorded. (The analyser is in the NO mode.)

1.8.6. NO_x mode

The NO analyser is then switched to the NO_x mode so that the gas mixture (consisting of NO, NO₂, O₂ and N₂) now passes through the converter. The indicated concentration (a) shall be recorded. (The analyser is in the NO_x mode.)

1.8.7. Deactivation of the ozonator

The ozonator is now deactivated. The mixture of gases described in section 1.8.6 passes through the converter into the detector. The indicated concentration (b) shall be recorded. (The analyser is in the NO_x mode.)

1.8.8. NO mode

Switched to NO mode with the ozonator deactivated, the flow of oxygen or synthetic air is also shut off. The NO_x reading of the analyser shall not deviate by more than ± 5 % from the value measured according to section 1.8.2. (The analyser is in the NO mode.)

1.8.9. Test interval

The efficiency of the converter must be checked monthly.

1.8.10. *Efficiency requirement*

The efficiency of the converter shall not be less than 90 %, but a higher efficiency of 95 % is strongly recommended.

Note: If, with the analyser in the most common range, the ozonator cannot give a reduction from 80 % to 20 % according to section 1.8.5, then the highest range which will give the reduction shall be used.

1.9. **Adjustment of the FID**

1.9.1. *Optimisation of the detector response*

The HFID must be adjusted as specified by the instrument manufacturer. A propane in air span gas should be used to optimise the response on the most common operating range.

With the fuel and airflow rates set at the manufacturer's recommendations, a 350 ± 75 ppm C span gas shall be introduced to the analyser. The response at a given fuel flow shall be determined from the difference between the span gas response and the zero gas response. The fuel flow shall be incrementally adjusted above and below the manufacturer's specification. The span and zero response at these fuel flows shall be recorded. The difference between the span and zero response shall be plotted and the fuel flow adjusted to the rich side of the curve. This is the initial flow rate setting, which may need further optimisation depending on the results of the hydrocarbon response factor and the oxygen interference check according to sections 1.9.2 and 1.9.3.

If the oxygen interference or the hydrocarbon response factors do not meet the following specifications, the airflow shall be incrementally adjusted above and below the manufacturer's specifications, sections 1.9.2 and 1.9.3 should be repeated for each flow.

1.9.2. *Hydrocarbon response factors*

The analyser shall be calibrated using propane in air and purified synthetic air, according to section 1.5.

Response factors shall be determined when introducing an analyser into service and after major service intervals. The response factor (R_f) for a particular hydrocarbon species is the ratio of the FID C1 reading to the gas concentration in the cylinder expressed by ppm C1.

The concentration of the test gas must be at a level to give a response of approximately 80 % of full scale. The concentration must be known to an accuracy of ± 2 % in reference to a gravimetric standard expressed in volume. In addition, the gas cylinder must be preconditioned for 24 hours at a temperature of $298 \text{ K } (25 \text{ }^\circ\text{C}) \pm 5 \text{ K}$.

The test gases to be used and the recommended relative response factor ranges are as follows:

- methane and purified synthetic air: $1,00 \leq R_f \leq 1,15$
- propylene and purified synthetic air: $0,90 \leq R_f \leq 1,1$
- toluene and purified synthetic air: $0,90 \leq R_f \leq 1,10$.

These values are relative to the response factor (R_f) of 1,00 for propane and purified synthetic air.

1.9.3. *Oxygen interference check*

The oxygen interference check shall be determined when introducing an analyser into service and after major service intervals. A range shall be chosen where the oxygen interference check gases will fall in the upper 50 %. The test shall be conducted with the oven temperature set as required. The oxygen interference gases are specified in section 1.2.3.

- (a) The analyser shall be zeroed.
- (b) The analyser shall be spanned with the 0 % oxygen blend for gasoline fuelled engines.

- (c) The zero response shall be rechecked. If it has changed more than 0,5 % of full scale subsections (a) and (b) of this section shall be repeated.
- (d) The 5 % and 10 % oxygen interference check gases shall be introduced.
- (e) The zero response shall be rechecked. If it has changed more than ± 1 % of full scale, the test shall be repeated.
- (f) The oxygen interference (% O₂I) shall be calculated for each mixture in step (d) as follows:

$$\text{O}_2\text{I} = \frac{(\text{B} - \text{C})}{\text{B}} \times 100 \quad \text{ppm C} = \frac{\text{A}}{\text{D}}$$

where:

A = hydrocarbon concentration (ppm C) of the span gas used in subsection (b)

B = hydrocarbon concentration (ppm C) of the oxygen interference check gases used in subsection (d)

C = analyser response

D = percent of full scale analyser response due to A

- (g) The % of oxygen interference (% O₂I) shall be less than ± 3 % for all required oxygen interference check gases prior to testing.
- (h) If the oxygen interference is greater than ± 3 %, the air flow above and below the manufacturer's specifications shall be incrementally adjusted, repeating section 1.9.1 for each flow.
- (i) If the oxygen interference is greater than ± 3 %, after adjusting the air flow, the fuel flow and thereafter the sample flow shall be varied, repeating section 1.9.1 for each new setting.
- (j) If the oxygen interference is still greater than ± 3 %, the analyser, FID fuel, or burner air shall be repaired or replaced prior to testing. This section shall then be repeated with the repaired or replaced equipment or gases.

1.10. Interference effects with CO, CO₂, NO_x and O₂ analysers

Gases other than the one being analysed can interfere with the reading in several ways. Positive interference occurs in NDIR and PMD instruments where the interfering gas gives the same effect as the gas being measured, but to a lesser degree. Negative interference occurs in NDIR instruments by the interfering gas broadening the absorption band of the measured gas, and in CLD instruments by the interfering gas quenching the radiation. The interference checks in sections 1.10.1 and 1.10.2 shall be performed prior to an analyser's initial use and after major service intervals, but at least once per year.

1.10.1. CO analyser interference check

Water and CO₂ can interfere with the CO analyser performance. Therefore a CO₂ span gas having a concentration of 80 % to 100 % of full scale of the maximum operating range used during testing shall be bubbled through water at room temperature and the analyser response recorded. The analyser response must not be more than 1 % of full scale for ranges equal to or above 300 ppm or more than 3 ppm for ranges below 300 ppm.

1.10.2. NO_x analyser quench checks

The two gases of concern for CLD (and HCLD) analysers are CO₂ and water vapour. Quench responses of these gases are proportional to their concentrations, and therefore require test techniques to determine the quench at the highest expected concentrations experienced during testing.

1.10.2.1. CO₂ quench check

A CO₂ span gas having a concentration of 80 % to 100 % of full scale of the maximum operating range shall be passed through the NDIR analyser and the CO₂ value recorded as A. It shall then be diluted approximately 50 % with NO span gas and passed through the NDIR and (H)CLD with the CO₂ and NO values recorded as B and C, respectively. The CO₂ shall be shut off and only the NO span gas is passed through the (H)CLD and the NO value recorded as D.

The quench, which shall not be greater than 3 % full scale, shall be calculated as follows:

$$\% \text{ CO}_2 \text{ quench} = \left[1 - \left(\frac{C \times A}{(D \times A) - (D \times B)} \right) \right] \times 100$$

where:

A: undiluted CO₂ concentration measured with NDIR %

B: diluted CO₂ concentration measured with NDIR %

C: diluted NO concentration measured with CLD ppm

D: undiluted NO concentration measured with CLD ppm

Alternative methods of diluting and quantifying CO₂ and NO span gas values, such as dynamic/mixing/blending, can be used.

1.10.2.2. Water quench check

This check applies to wet gas concentration measurements only. Calculation of water quench must consider dilution of the NO span gas with water vapour and scaling of water vapour concentration of the mixture to that expected during testing.

A NO span gas having a concentration of 80 % to 100 % of full scale to the normal operating range shall be passed through the (H)CLD and the NO value recorded as D. The NO span gas shall then be bubbled through water at room temperature and passed through the (H)CLD and the NO value recorded as C. The water temperature shall be determined and recorded as F. The mixture's saturation vapour pressure that corresponds to the bubbler water temperature (F) shall be determined and recorded as G. The water vapour concentration (in %) of the mixture shall be calculated as follows:

$$H = 100 \times \left(\frac{G}{p_B} \right)$$

and recorded as H. The expected diluted NO span gas (in water vapour) concentration shall be calculated as follows:

$$D_e = D \times \left(1 - \frac{H}{100} \right)$$

and recorded as D_e.

The water quench shall not be greater than 3 % and shall be calculated as follows:

$$\% \text{ H}_2\text{O quench} = 100 \times \left(\frac{D_e - C}{D_e} \right) \times \left(\frac{H_m}{H} \right)$$

where:

D_e: expected diluted NO concentration (ppm)

C: diluted NO concentration (ppm)

H_m: maximum water vapour concentration

H: actual water vapour concentration (%).

Note: It is important that the NO span gas contains minimal NO₂ concentration for this check, since absorption of NO₂ in water has not been accounted for in the quench calculations.

1.10.3. O₂ analyser interference

Instrument response of a PMD analyser caused by gases other than oxygen is comparatively slight. The oxygen equivalents of the common exhaust gas constituents are shown in table 1.

Tabel 1 — Oxygen equivalents

Gas	O ₂ equivalent %
Carbon dioxide (CO ₂)	- 0,623
Carbon monoxide (CO)	- 0,354
Nitrogen oxide (NO)	+ 44,4
Nitrogen dioxide (NO ₂)	+ 28,7
Water (H ₂ O)	- 0,381

The observed oxygen concentration shall be corrected by the following formula if high precision measurements are to be done:

$$\text{Interference} = \frac{(\text{Equivalent \% O}_2 \times \text{Obs. conc.})}{100}$$

1.11. Calibration intervals

The analysers shall be calibrated according to section 1.5 at least every three months or whenever a system repair or change is made that could influence calibration.

Appendix 3

1. DATA EVALUATION AND CALCULATIONS

1.1. Gaseous emissions evaluation

For the evaluation of the gaseous emissions, the chart reading for a minimum of the last 120 s of each mode shall be averaged, and the average concentrations (conc) of HC, CO, NO_x and CO₂ during each mode shall be determined from the average chart readings and the corresponding calibration data. A different type of recording can be used if it ensures an equivalent data acquisition.

The average background concentration (conc_d) may be determined from the bag readings of the dilution air or from the continuous (non-bag) background reading and the corresponding calibration data.

1.2. Calculation of the gaseous emissions

The finally reported test results shall be derived through the following steps.

1.2.1. *Dry/wet correction*

The measured concentration, if not already measured on a wet basis, shall be converted to a wet basis:

$$\text{conc (wet)} = k_w \times \text{conc (dry)}$$

For the raw exhaust gas:

$$k_w = k_{w,r} = \frac{1}{1 + \alpha \times 0,005 \times (\% \text{ CO [dry]} + \% \text{ CO}_2 \text{ [dry]}) - 0,01 \times \% \text{ H}_2 \text{ [dry]} + k_{w2}}$$

where α is the hydrogen to carbon ratio in the fuel.

The H_2 concentration in the exhaust shall be calculated:

$$\text{H}_2 \text{ [dry]} = \frac{0,5 \times \alpha \times \% \text{ CO [dry]} \times (\% \text{ CO [dry]} + \% \text{ CO}_2 \text{ [dry]})}{\% \text{ CO [dry]} + (3 \times \% \text{ CO}_2 \text{ [dry]})}$$

The factor k_{w2} shall be calculated:

$$k_{w2} = \frac{1,608 \times H_a}{1\ 000 + (1,608 \times H_a)}$$

with H_a absolute humidity of the intake air as g of water per kg of dry air.

For the diluted exhaust gas:

for wet CO_2 measurement:

$$k_w = k_{w,e,1} = \left(1 - \frac{\alpha \times \% \text{ CO}_2 \text{ [wet]}}{200} \right) - k_{w1}$$

or, for dry CO_2 measurement:

$$k_w = k_{w,e,2} = \left(\frac{(1 - k_{w1})}{1 + \frac{\alpha \times \% \text{ CO}_2 \text{ [dry]}}{200}} \right)$$

where α is the hydrogen to carbon ratio in the fuel.

The factor k_{w1} shall be calculated from the following equations:

$$k_{w1} = \frac{1,608 \times [H_d \times (1 - 1/DF) + H_a \times (1/DF)]}{1\ 000 + 1,608 \times [H_d \times (1 - 1/DF) + H_a \times (1/DF)]}$$

where:

H_d absolute humidity of the dilution air, g of water per kg of dry air

H_a absolute humidity of the intake air, g of water per kg of dry air

$$DF = \frac{13,4}{\% \text{ conc}_{\text{CO}_2} + (\text{ppm conc}_{\text{CO}} + \text{ppm conc}_{\text{HC}}) \times 10^{-4}}$$

For the dilution air:

$$k_{w,d} = 1 - k_{w1}$$

The factor k_{w1} shall be calculated from the following equations:

$$DF = \frac{13,4}{\% \text{ conc}_{\text{CO}_2} + (\text{ppm conc}_{\text{CO}} + \text{ppm conc}_{\text{HC}}) \times 10^{-4}}$$

$$k_{w1} = \frac{1,608 \times [H_d \times (1 - 1/DF) + H_a \times (1/DF)]}{1\,000 + 1,608 \times [H_d \times (1 - 1/DF) + H_a \times (1/DF)]}$$

where:

H_d absolute humidity of the dilution air, g of water per kg of dry air

H_a absolute humidity of the intake air, g of water per kg of dry air

$$DF = \frac{13,4}{\% \text{ conc}_{\text{CO}_2} + (\text{ppm conc}_{\text{CO}} + \text{ppm conc}_{\text{HC}}) \times 10^{-4}}$$

For the intake air (if different from the dilution air):

$$k_{w,a} = 1 - k_{w2}$$

The factor k_{w2} shall be calculated from the following equations:

$$k_{w2} = \frac{1,608 \times H_a}{1\,000 + (1,608 \times H_a)}$$

with H_a absolute humidity of the intake air, g of water per kg of dry air.

1.2.2. Humidity correction for NO_x

As the NO_x emission depends on ambient air conditions, the NO_x concentration shall be multiplied by the factor K_H taking into account humidity:

$$K_H = 0,6272 + 44,030 \times 10^{-3} \times H_a - 0,862 \times 10^{-3} \times H_a^2 \text{ (for 4 stroke engines)}$$

$$K_H = 1 \text{ (for 2 stroke engines)}$$

with H_a absolute humidity of the intake air as g of water per kg of dry air.

1.2.3. Calculation of emission mass flow rate

The emission mass flow rates Gas_{mass} [g/h] for each mode shall be calculated as follows.

(a) For the raw exhaust gas ⁽¹⁾:

$$\text{Gas}_{\text{mass}} = \frac{\text{MW}_{\text{Gas}}}{\text{MW}_{\text{FUEL}}} \times \frac{1}{\{(\% \text{ CO}_2 \text{ [wet]} - \% \text{ CO}_{2\text{AIR}}) + \% \text{ CO [wet]} + \% \text{ HC [wet]}\}} \times \% \text{ conc} \times \text{G}_{\text{FUEL}} \times 1\,000$$

where:

G_{FUEL} [kg/h] is the fuel mass flow rate;

MW_{Gas} [kg/kmol] is the molecular weight of the individual gas shown in table 1;

Table 1 — Molecular weights

Gas	MW_{Gas} [kg/kmol]
NO_x	46,01
CO	28,01
HC	$\text{MW}_{\text{HC}} = \text{MW}_{\text{FUEL}}$
CO_2	44,01

⁽¹⁾ In the case of NO_x the concentration has to be multiplied by the humidity correction factor K_H (humidity correction factor for NO_x).

- $MW_{\text{FUEL}} = 12,011 + \alpha \times 1,00794 + \beta \times 15,9994$ [kg/kmole] is the fuel molecular weight with α hydrogen to carbon ratio and β oxygen to carbon ratio of the fuel ⁽¹⁾;
- $CO_{2\text{AIR}}$ is the CO_2 concentration in the intake air (that is assumed equal to 0,04 % if not measured).

(b) For the diluted exhaust gas ⁽²⁾:

$$Gas_{\text{mass}} = u \times \text{conc}_c \times G_{\text{TOTW}}$$

where:

- G_{TOTW} [kg/h] is the diluted exhaust gas mass flow rate on wet basis that, when using a full flow dilution system, shall be determined according to Annex III, Appendix 1, section 1.2.4,
- conc_c is the background corrected concentration:

$$\text{conc}_c = \text{conc} - \text{conc}_d \times (1 - 1/\text{DF})$$

with

$$\text{DF} = \frac{13,4}{\% \text{ conc}_{CO_2} + (\text{ppm conc}_{CO} + \text{ppm conc}_{HC}) \times 10^{-4}}$$

The u coefficient is shown in table 2.

Table 2 — Values of u coefficient

Gas	u	conc
NO_x	0,001587	ppm
CO	0,000966	ppm
HC	0,000479	ppm
CO_2	15,19	%

Values of the u coefficient are based upon a molecular weight of the dilute exhaust gases equal to 29 [kg/kmol]; the value of u for HC is based upon an average carbon to hydrogen ratio of 1:1,85.

1.2.4. Calculation of specific emissions

The specific emission (g/kWh) shall be calculated for all individual components:

$$\text{Individual gas} = \frac{\sum_{i=1}^n (Gas_{\text{mass}_i} \times WF_i)}{\sum_{i=1}^n (P_i \times WF_i)}$$

where $P_i = P_{M,i} + P_{AE,i}$

When auxiliaries, such as cooling fan or blower, are fitted for the test, the power absorbed shall be added to the results except for engines where such auxiliaries are an integral part of the engine. The fan or blower power shall be determined at the speeds used for the tests either by calculation from standard characteristics or by practical tests (Appendix 3 of Annex VII).

⁽¹⁾ In the ISO 8178-1 a more complete formula of the fuel molecular weight is quoted (formula 50 of Chapter 13.5.1(b)). The formula takes into account not only the hydrogen to carbon ratio and the oxygen to carbon ratio but also other possible fuel components such as sulphur and nitrogen. However, as the SI engines of the Directive are tested with a petrol (quoted as a reference fuel in Annex V) containing usually only carbon and hydrogen, the simplified formula is considered.

⁽²⁾ In the case of NO_x the concentration has to be multiplied by the humidity correction factor K_H (humidity correction factor for NO_x).

The weighting factors and the number of the n modes used in the above calculation are shown in Annex IV, section 3.5.1.1.

2. EXAMPLES

2.1. Raw exhaust gas data from a four-stroke SI engine

With reference to the experimental data (table 3), calculations are carried out first for mode 1 and then are extended to other test modes using the same procedure.

Table 3 — Experimental data of a four-stroke SI engine

Mode		1	2	3	4	5	6
Engine speed	min ⁻¹	2 550	2 550	2 550	2 550	2 550	1 480
Power	kW	9,96	7,5	4,88	2,36	0,94	0
Load percent	%	100	75	50	25	10	0
Weighting factors	—	0,090	0,200	0,290	0,300	0,070	0,050
Barometric pressure	kPa	101,0	101,0	101,0	101,0	101,0	101,0
Air temperature	°C	20,5	21,3	22,4	22,4	20,7	21,7
Air relative humidity	%	38,0	38,0	38,0	37,0	37,0	38,0
Air absolute humidity	g _{H2O} /kg _{air}	5,696	5,986	6,406	6,236	5,614	6,136
CO dry	ppm	60 995	40 725	34 646	41 976	68 207	37 439
NO _x wet	ppm	726	1 541	1 328	377	127	85
HC wet	ppm C1	1 461	1 308	1 401	2 073	3 024	9 390
CO ₂ dry	% Vol.	11,4098	12,691	13,058	12,566	10,822	9,516
Fuel mass flow	kg/h	2,985	2,047	1,654	1,183	1,056	0,429
Fuel H/C ratio α	—	1,85	1,85	1,85	1,85	1,85	1,85
Fuel O/C ratio β		0	0	0	0	0	0

2.1.1. Dry/wet correction factor k_w

The dry/wet correction factor k_w shall be calculated for converting dry CO and CO₂ measurements on a wet basis:

$$k_w = k_{w,r} = \frac{1}{1 + \alpha \times 0,005 \times (\% \text{ CO [dry]} + \% \text{ CO}_2 \text{ [dry]}) - 0,01 \times \% \text{ H}_2 \text{ [dry]} + k_{w2}}$$

where:

$$\text{H}_2 \text{ [dry]} = \frac{0,5 \times \alpha \times \% \text{ CO [dry]} \times (\% \text{ CO [dry]} + \% \text{ CO}_2 \text{ [dry]})}{\% \text{ CO [dry]} + (3 \times \% \text{ CO}_2 \text{ [dry]})}$$

and

$$k_{w2} = \frac{1,608 \times H_a}{1\,000 + (1,608 \times H_a)}$$

$$H_2 \text{ [dry]} = \frac{0,5 \times 1,85 \times 6,0995 \times (6,0995 + 11,4098)}{6,0995 + (3 \times 11,4098)} = 2,450 \%$$

$$k_{w2} = \frac{1,608 \times 5,696}{1\,000 + (1,608 \times 5,696)} = 0,009$$

$$k_w = k_{w,r} = \frac{1}{1 + 1,85 \times 0,005 \times (6,0995 + 11,4098) - 0,01 \times 2,450 + 0,009} = 0,872$$

$$\text{CO [wet]} = \text{CO [dry]} \times k_w = 60\,995 \times 0,872 = 53\,198 \text{ ppm}$$

$$\text{CO}_2 \text{ [wet]} = \text{CO}_2 \text{ [dry]} \times k_w = 11,410 \times 0,872 = 9,951 \text{ \% Vol}$$

Table 4 — CO and CO₂ wet values according to different test modes

Mode		1	2	3	4	5	6
H ₂ dry	%	2,450	1,499	1,242	1,554	2,834	1,422
k _{w2}	—	0,009	0,010	0,010	0,010	0,009	0,010
k _w	—	0,872	0,870	0,869	0,870	0,874	0,894
CO wet	ppm	53 198	35 424	30 111	36 518	59 631	33 481
CO ₂ wet	%	9,951	11,039	11,348	10,932	9,461	8,510

2.1.2. HC emissions

$$HC_{\text{mass}} = \frac{MW_{\text{HC}}}{MW_{\text{FUEL}}} \times \frac{1}{\{(\% \text{ CO}_2 \text{ [wet]} - \% \text{ CO}_{2\text{AIR}}) + \% \text{ CO [wet]} + \% \text{ HC [wet]}\}} \times \% \text{ conc} \times G_{\text{FUEL}} \times 1\,000$$

Where:

$$MW_{\text{HC}} = MW_{\text{FUEL}}$$

$$MW_{\text{FUEL}} = 12,011 + \alpha \times 1,00794 = 13,876$$

$$HC_{\text{mass}} = \frac{13,876}{13,876} \times \frac{1}{(9,951 - 0,04 + 5,3198 + 0,1461)} \times 0,1461 \times 2,985 \times 1\,000 = 28,361 \text{ g/h}$$

Table 5 — HC emissions [g/h] according to different test modes

Mode	1	2	3	4	5	6
HC _{mass}	28,361	18,248	16,026	16,625	20,357	31,578

2.1.3. NO_x emissions

At first the humidity correction factor K_H of NO_x emissions shall be calculated:

$$K_H = 0,6272 + 44,030 \times 10^{-3} \times H_a - 0,862 \times 10^{-3} \times H_a^2$$

$$K_H = 0,6272 + 44,030 \times 10^{-3} \times 5,696 - 0,862 \times 10^{-3} \times (5,696)^2 = 0,850$$

Table 6 — Humidity correction factor K_H of NO_x emissions according to different modes

Mode	1	2	3	4	5	6
K_H	0,850	0,860	0,874	0,868	0,847	0,865

Then $\text{NO}_{x\text{mass}}$ [g/h] shall be calculated:

$$\text{NO}_{x\text{mass}} = \frac{\text{MW}_{\text{NO}_x}}{\text{MW}_{\text{FUEL}}} \times \frac{1}{\{(\% \text{CO}_2 [\text{wet}] - \% \text{CO}_{2\text{AIR}}) + \% \text{CO} [\text{wet}] + \% \text{HC} [\text{wet}]\}} \times \% \text{conc} \times K_H \times G_{\text{FUEL}} \times 1\,000$$

$$\text{NO}_{x\text{mass}} = \frac{46,01}{13,876} \times \frac{1}{(9,951 - 0,04 + 5,3198 + 0,1461)} \times 0,073 \times 0,85 \times 2,985 \times 1\,000 = 39,717 \text{ g/h}$$

Table 7 — NO_x emissions [g/h] according to the different test modes

Mode	1	2	3	4	5	6
$\text{NO}_{x\text{mass}}$	39,717	61,291	44,013	8,703	2,401	0,820

2.1.4 CO emissions

$$\text{CO}_{\text{mass}} = \frac{\text{MW}_{\text{CO}}}{\text{MW}_{\text{FUEL}}} \times \frac{1}{\{(\% \text{CO}_2 [\text{wet}] - \% \text{CO}_{2\text{AIR}}) + \% \text{CO} [\text{wet}] + \% \text{HC} [\text{wet}]\}} \times \% \text{conc} \times G_{\text{FUEL}} \times 1\,000$$

$$\text{CO}_{2\text{mass}} = \frac{44,01}{13,876} \times \frac{1}{(9,951 - 0,04 + 5,3198 + 0,1461)} \times 9,951 \times 2,985 \times 1\,000 = 6\,126,806 \text{ g/h}$$

Table 8 — CO emissions [g/h] according to different test modes

Mode	1	2	3	4	5	6
CO_{mass}	2 084,588	997,638	695,278	591,183	810,334	227,285

2.1.5. CO_2 emissions

$$\text{CO}_{2\text{mass}} = \frac{\text{MW}_{\text{CO}_2}}{\text{MW}_{\text{FUEL}}} \times \frac{1}{\{(\% \text{CO}_2 [\text{wet}] - \% \text{CO}_{2\text{AIR}}) + \% \text{CO} [\text{wet}] + \% \text{HC} [\text{wet}]\}} \times \% \text{conc} \times G_{\text{FUEL}} \times 1\,000$$

$$\text{CO}_{2\text{mass}} = \frac{44,01}{13,876} \times \frac{1}{(9,951 - 0,04 + 5,3198 + 0,1461)} \times 9,951 \times 2,985 \times 1\,000 = 6\,126,806 \text{ g/h}$$

Table 9 — CO_2 emissions [g/h] according to different test modes

Mode	1	2	3	4	5	6
$\text{CO}_{2\text{mass}}$	6 126,806	4 884,739	4 117,202	2 780,662	2 020,061	907,648

2.1.6. Specific emissions

The specific emission (g/kWh) shall be calculated for all individual components:

$$\text{Individual gas} = \frac{\sum_{i=1}^n (\text{Gas}_{\text{mass}_i} \times \text{WF}_i)}{\sum_{i=1}^n (\text{P}_i \times \text{WF}_i)}$$

Table 10 — Emissions [g/h] and weighting factors according to the test modes

Mode		1	2	3	4	5	6
HC _{mass}	g/h	28,361	18,248	16,026	16,625	20,357	31,578
NO _{xmass}	g/h	39,717	61,291	44,013	8,703	2,401	0,820
CO _{mass}	g/h	2 084,588	997,638	695,278	591,183	810,334	227,285
CO _{2mass}	g/h	6 126,806	4 884,739	4 117,202	2 780,662	2 020,061	907,648
Power P ₁	kW	9,96	7,50	4,88	2,36	0,94	0
Weighting factors WF ₁	—	0,090	0,200	0,290	0,300	0,070	0,050

$$HC = \frac{28,361 \times 0,090 + 18,248 \times 0,200 + 16,026 \times 0,290 + 16,625 \times 0,300 + 20,357 \times 0,070 + 31,578 \times 0,050}{9,96 \times 0,090 + 7,50 \times 0,200 + 4,88 \times 0,290 + 2,36 \times 0,300 + 0,940 \times 0,070 + 0 \times 0,050} = 4,11 \text{ g/kWh}$$

$$NO_x = \frac{39,717 \times 0,090 + 61,291 \times 0,200 + 44,013 \times 0,290 + 8,703 \times 0,300 + 2,401 \times 0,070 + 0,820 \times 0,050}{9,96 \times 0,090 + 7,50 \times 0,200 + 4,88 \times 0,290 + 2,36 \times 0,300 + 0,940 \times 0,070 + 0 \times 0,050} = 6,85 \text{ g/kWh}$$

$$CO = \frac{2\,084,59 \times 0,090 + 997,64 \times 0,200 + 695,28 \times 0,290 + 591,18 \times 0,300 + 810,33 \times 0,070 + 227,92 \times 0,050}{9,96 \times 0,090 + 7,50 \times 0,200 + 4,88 \times 0,290 + 2,36 \times 0,300 + 0,940 \times 0,070 + 0 \times 0,050} = 181,93 \text{ g/kWh}$$

$$CO_2 = \frac{6\,126,81 \times 0,090 + 4\,884,74 \times 0,200 + 4\,117,20 \times 0,290 + 2\,780,66 \times 0,300 + 2\,020,06 \times 0,070 + 907,65 \times 0,050}{9,96 \times 0,090 + 7,50 \times 0,200 + 4,88 \times 0,290 + 2,36 \times 0,300 + 0,940 \times 0,070 + 0 \times 0,050} = 816,36 \text{ g/kWh}$$

2.2. Raw exhaust gas data from a two-stroke SI engine

With reference to the experimental data (table 11), calculations shall be carried out first for mode 1 and then extended to the other test mode using the same procedure.

Table 11 — Experimental data of a two-stroke SI engine

Mode		1	2
Engine speed	min ⁻¹	9 500	2 800
Power	kW	2,31	0
Load percent	%	100	0
Weighting factors	—	0,9	0,1
Barometric pressure	kPa	100,3	100,3
Air temperature	°C	25,4	25
Air relative humidity	%	38,0	38,0
Air absolute humidity	g _{H2O} /kg _{air}	7,742	7,558
CO dry	ppm	37 086	16 150
NO _x wet	ppm	183	15
HC wet	ppmC1	14 220	13 179
CO ₂ dry	% Vol.	11,986	11,446
Fuel mass flow	kg/h	1,195	0,089
Fuel H/C ratio α	—	1,85	1,85
Fuel O/C ratio β		0	0

2.2.1 Dry/wet correction factor k_w

The dry/wet correction factor k_w shall be calculated for converting dry CO and CO₂ measurements on a wet basis:

$$k_w = k_{w,r} = \frac{1}{1 + \alpha \times 0,005 \times (\% \text{ CO [dry]} + \% \text{ CO}_2 \text{ [dry]}) - 0,01 \times \% \text{ H}_2 \text{ [dry]} + k_{w2}}$$

Where:

$$\text{H}_2 \text{ [dry]} = \frac{0,5 \times \alpha \times \% \text{ CO [dry]} \times (\% \text{ CO [dry]} + \% \text{ CO}_2 \text{ [dry]})}{\% \text{ CO [dry]} + (3 \times \% \text{ CO}_2 \text{ [dry]})}$$

$$\text{H}_2 \text{ [dry]} = \frac{0,5 \times 1,85 \times 3,7086 \times (3,7086 + 11,986)}{3,7086 + (3 \times 11,986)} = 1,357 \%$$

$$k_{w2} = \frac{1,608 \times H_a}{1\,000 + (1,608 \times H_a)}$$

$$k_{w2} = \frac{1,608 \times 7,742}{1\,000 + (1,608 \times 7,742)} = 0,012$$

$$k_w = k_{w,r} = \frac{1}{1 + 1,85 \times 0,005 \times (3,7086 + 11,986) - 0,01 \times 1,357 + 0,012} = 0,874$$

$$\text{CO [wet]} = \text{CO [dry]} \times k_w = 37\,086 \times 0,874 = 32\,420 \text{ ppm}$$

$$\text{CO}_2 \text{ [wet]} = \text{CO}_2 \text{ [dry]} \times k_w = 11,986 \times 0,874 = 10,478 \text{ \% Vol}$$

Table 12 — CO and CO₂ wet values according to different test modes

Mode		1	2
H ₂ dry	%	1,357	0,543
k _{w2}	—	0,012	0,012
k _w	—	0,874	0,887
CO wet	ppm	32 420	14 325
CO ₂ wet	%	10,478	10,153

2.2.2. HC emissions

$$\text{HC}_{\text{mass}} = \frac{\text{MW}_{\text{HC}}}{\text{MW}_{\text{FUEL}}} \times \frac{1}{\{(\% \text{ CO}_2 \text{ [wet]} - \% \text{ CO}_{2\text{AIR}}) + \% \text{ CO [wet]} + \% \text{ HC [wet]}\}} \times \% \text{ conc} \times G_{\text{FUEL}} \times 1\,000$$

where:

$$\text{MW}_{\text{HC}} = \text{MW}_{\text{FUEL}}$$

$$\text{MW}_{\text{FUEL}} = 12,011 + \alpha \times 1,00794 = 13,876$$

$$\text{HC}_{\text{mass}} = \frac{13,876}{13,876} \times \frac{1}{(10,478 - 0,04 + 3,2420 + 1,422)} \times 1,422 \times 1,195 \times 1\,000 = 112,520 \text{ g/h}$$

Table 13 — HC emissions [g/h] according to test modes

Mode	1	2
HC _{mass}	112,520	9,119

2.2.3. *NO_x emissions*

The factor K_H for the correction of the NO_x emissions is equal to 1 for two-stroke engines:

$$NO_{xmass} = \frac{MW_{NO_x}}{MW_{FUEL}} \times \frac{1}{\{(\% CO_2 \text{ [wet]} - \% CO_{2AIR}) + \% CO \text{ [wet]} + \% HC \text{ [wet]}\}} \times \% \text{ conc} \times K_H \times G_{FUEL} \times 1\,000$$

$$NO_{xmass} = \frac{46,01}{13,876} \times \frac{1}{(10,478 - 0,04 + 3,2420 + 1,422)} \times 0,0183 \times 1 \times 1,195 \times 1\,000 = 4,800 \text{ g/h}$$

Table 14 — NO_x emissions [g/h] according to test modes

Mode	1	2
NO _{xmass}	4,800	0,034

2.2.4. *CO emissions*

$$CO_{mass} = \frac{MW_{CO}}{MW_{FUEL}} \times \frac{1}{\{(\% CO_2 \text{ [wet]} - \% CO_{2AIR}) + \% CO \text{ [wet]} + \% HC \text{ [wet]}\}} \times \% \text{ conc} \times G_{FUEL} \times 1\,000$$

$$CO_{mass} = \frac{28,01}{13,876} \times \frac{1}{(10,478 - 0,04 + 3,2420 + 1,422)} \times 3,2420 \times 1,195 \times 1\,000 = 517,851 \text{ g/h}$$

Table 15 — CO emissions [g/h] according to test modes

Mode	1	2
CO _{mass}	517,851	20,007

2.2.5. *CO₂ emissions*

$$CO_{2mass} = \frac{MW_{CO_2}}{MW_{FUEL}} \times \frac{1}{\{(\% CO_2 \text{ [wet]} - \% CO_{2AIR}) + \% CO \text{ [wet]} + \% HC \text{ [wet]}\}} \times \% \text{ conc} \times G_{FUEL} \times 1\,000$$

$$CO_{2mass} = \frac{44,01}{13,876} \times \frac{1}{(10,478 - 0,04 + 3,2420 + 1,422)} \times 10,478 \times 1,195 \times 1\,000 = 2\,629,658 \text{ g/h}$$

Table 16 — CO₂ emissions [g/h] according to test modes

Mode	1	2
CO _{2mass}	2 629,658	222,799

2.2.6. *Specific emissions*

The specific emission (g/kWh) shall be calculated for all individual components in the following way:

$$\text{Individual gas} = \frac{\sum_{i=1}^n (\text{Gas}_{mass_i} \times WF_i)}{\sum_{i=1}^n (P_i \times WF_i)}$$

Table 17 — Emissions [g/h] and weighting factors in two test modes

Mode		1	2
HC _{mass}	g/h	112,520	9,119
NO _{xmass}	g/h	4,800	0,034
CO _{mass}	g/h	517,851	20,007
CO _{2mass}	g/h	2 629,658	222,799
Power P _{II}	kW	2,31	0
Weighting factors WF _i	—	0,85	0,15

$$\text{HC} = \frac{112,52 \times 0,85 + 9,119 \times 0,15}{2,31 \times 0,85 + 0 \times 0,15} = 49,4 \text{ g/kWh}$$

$$\text{NO}_x = \frac{4,800 \times 0,85 + 0,034 \times 0,15}{2,31 \times 0,85 + 0 \times 0,15} = 2,08 \text{ g/kWh}$$

$$\text{CO} = \frac{517,851 \times 0,85 + 20,007 \times 0,15}{2,31 \times 0,85 + 0 \times 0,15} = 225,71 \text{ g/kWh}$$

$$\text{CO}_2 = \frac{2\,629,658 \times 0,85 + 222,799 \times 0,15}{2,31 \times 0,85 + 0 \times 0,15} = 1\,155,4 \text{ g/kWh}$$

2.3. Diluted exhaust gas data from a four-stroke SI engine

With reference to the experimental data (table 18), calculations shall be carried out first for mode 1 and then extended to other test modes using the same procedure.

Table 18 — Experimental data of a four-stroke SI engine

Mode		1	2	3	4	5	6
Engine speed	min ⁻¹	3 060	3 060	3 060	3 060	3 060	2 100
Power	kW	13,15	9,81	6,52	3,25	1,28	0
Load percent	%	100	75	50	25	10	0
Weighting factors	—	0,090	0,200	0,290	0,300	0,070	0,050
Barometric pressure	kPa	980	980	980	980	980	980
Intake air temperature (1)	°C	25,3	25,1	24,5	23,7	23,5	22,6
Intake air relative humidity (1)	%	19,8	19,8	20,6	21,5	21,9	23,2
Intake air absolute humidity (1)	g _{H2O} /kg _{air}	4,08	4,03	4,05	4,03	4,05	4,06
CO dry	ppm	3 681	3 465	2 541	2 365	3 086	1 817
NO _x wet	ppm	85,4	49,2	24,3	5,8	2,9	1,2
HC wet	ppm C1	91	92	77	78	119	186
CO ₂ dry	% Vol	1,038	0,814	0,649	0,457	0,330	0,208

Mode		1	2	3	4	5	6
CO dry (background)	ppm	3	3	3	2	2	3
NO _x wet (background)	ppm	0,1	0,1	0,1	0,1	0,1	0,1
HC wet (background)	ppm C1	6	6	5	6	6	4
CO ₂ dry (background)	% Vol	0,042	0,041	0,041	0,040	0,040	0,040
Dil. exh. gas mass flow G _{TOTW}	kg/h	625,722	627,171	623,549	630,792	627,895	561,267
Fuel H/C ratio α	—	1,85	1,85	1,85	1,85	1,85	1,85
Fuel O/C ratio β		0	0	0	0	0	0

(¹) Dilution air conditions equal to intake air conditions.

2.3.1. Dry/wet correction factor k_w

The dry/wet correction factor k_w shall be calculated for converting dry CO and CO₂ measurements on a wet basis.

For the diluted exhaust gas:

$$k_w = k_{w,e,2} = \left(\frac{(1 - k_{w1})}{1 + \frac{\alpha \times \% \text{CO}_2 [\text{dry}]}{200}} \right)$$

where:

$$k_{w1} = \frac{1,608 \times [H_d \times (1 - 1/DF) + H_a \times (1/DF)]}{1\,000 + 1,608 \times [H_d \times (1 - 1/DF) + H_a \times (1/DF)]}$$

$$DF = \frac{13,4}{\% \text{conc}_{\text{CO}_2} + (\text{ppm conc}_{\text{CO}} + \text{ppm conc}_{\text{HC}}) \times 10^{-4}}$$

$$DF = \frac{13,4}{1,038 + (3\,681 + 91) \times 10^{-4}} = 9,465$$

$$k_{w1} = \frac{1,608 \times [4,08 \times (1 - 1/9,465) + 4,08 \times (1/9,465)]}{1\,000 + 1,608 \times [4,08 \times (1 - 1/9,465) + 4,08 \times (1/9,465)]} = 0,007$$

$$k_w = k_{w,e,2} = \left(\frac{(1 - 0,007)}{1 + \frac{1,85 \times 1,038}{200}} \right) = 0,984$$

$$\text{CO} [\text{wet}] = \text{CO} [\text{dry}] \times k_w = 3\,681 \times 0,984 = 3\,623 \text{ ppm}$$

$$\text{CO}_2 [\text{wet}] = \text{CO}_2 [\text{dry}] \times k_w = 1,038 \times 0,984 = 1,0219 \%$$

Table 19 — CO and CO₂ wet values for the diluted exhaust gas according to test modes

Mode		1	2	3	4	5	6
DF	—	9,465	11,454	14,707	19,100	20,612	32,788
k _{w1}	—	0,007	0,006	0,006	0,006	0,006	0,006
k _w	—	0,984	0,986	0,988	0,989	0,991	0,992
CO wet	ppm	3 623	3 417	2 510	2 340	3 057	1 802
CO ₂ wet	%	1,0219	0,8028	0,6412	0,4524	0,3264	0,2066

For the dilution air:

$$k_{w,d} = 1 - k_{w1}$$

Where the factor k_{w1} is the same as that already calculated for the diluted exhaust gas.

$$k_{w,d} = 1 - 0,007 = 0,993$$

$$\text{CO [wet]} = \text{CO [dry]} \times k_w = 3 \times 0,993 = 3 \text{ ppm}$$

$$\text{CO}_2 \text{ [wet]} = \text{CO}_2 \text{ [dry]} \times k_w = 0,042 \times 0,993 = 0,0421 \text{ \% Vol}$$

Table 20 — CO and CO₂ wet values for the dilution air according to test modes

Mode		1	2	3	4	5	6
K _{w1}	—	0,007	0,006	0,006	0,006	0,006	0,006
K _w	—	0,993	0,994	0,994	0,994	0,994	0,994
CO wet	ppm	3	3	3	2	2	3
CO ₂ wet	%	0,0421	0,0405	0,0403	0,0398	0,0394	0,0401

2.3.2. HC emissions

$$\text{HC}_{\text{mass}} = u \times \text{conc}_c \times G_{\text{TOTW}}$$

Where:

$$u = 0,000478 \text{ from table 2}$$

$$\text{conc}_c = \text{conc} - \text{conc}_d \times (1-1/\text{DF})$$

$$\text{conc}_c = 91 - 6 \times (1-1/9,465) = 86 \text{ ppm}$$

$$\text{HC}_{\text{mass}} = 0,000478 \times 86 \times 625,722 = 25,666 \text{ g/h}$$

Table 21 — HC emissions [g/h] according to test modes

Mode	1	2	3	4	5	6
HC _{mass}	25,666	25,993	21,607	21,850	34,074	48,963

2.3.3. *NO_x emissions*

The factor K_H for the correction of the NO_x emissions shall be calculated from:

$$K_H = 0,6272 + 44,030 \times 10^{-3} \times H_a - 0,862 \times 10^{-3} \times H_a^2$$

$$K_H = 0,6272 + 44,030 \times 10^{-3} \times 4,8 - 0,862 \times 10^{-3} \times (4,08)^2 = 0,79$$

Table 22 — Humidity correction factor K_H of NO_x emissions according to test modes

Mode	1	2	3	4	5	6
K_H	0,793	0,791	0,791	0,790	0,791	0,792

$$NO_{xmass} = u \times conc_c \times K_H \times G_{TOTW}$$

where:

$$u = 0,001587 \text{ from table 2}$$

$$conc_c = conc - conc_d \times (1-1/DF)$$

$$conc_c = 85 - 0 \times (1-1/9,465) = 85 \text{ ppm}$$

$$NO_{xmass} = 0,001587 \times 85 \times 0,79 \times 625,722 = 67,168 \text{ g/h}$$

Table 23 — NO_x emissions [g/h] according to test modes

Mode	1	2	3	4	5	6
NO_{xmass}	67,168	38,721	19,012	4,621	2,319	0,811

2.3.4. *CO emissions*

$$CO_{mass} = u \times conc_c \times G_{TOTW}$$

where:

$$u = 0,000966 \text{ from table 2}$$

$$conc_c = conc - conc_d \times (1-1/DF)$$

$$conc_c = 3\,622 - 3 \times (1-1/9,465) = 3\,620 \text{ ppm}$$

$$CO_{mass} = 0,000966 \times 3\,620 \times 625,722 = 2\,188,001 \text{ g/h}$$

Table 24 — CO emissions [g/h] according to test modes

Mode	1	2	3	4	5	6
CO_{mass}	2 188,001	2 068,760	1 510,187	1 424,792	1 853,109	975,435

2.3.5. CO₂ emissions

$$CO_{2mass} = u \times conc_c \times G_{TOTW}$$

where:

$$u = 15,19 \text{ from table 2}$$

$$conc_c = conc - conc_d \times (1-1/DF)$$

$$conc_c = 1,0219 - 0,0421 \times (1-1/9,465) = 0,9842 \% \text{ Vol}$$

$$CO_{2mass} = 15,19 \times 0,9842 \times 625,722 = 9\,354,488 \text{ g/h}$$

Table 25 — CO₂ emissions [g/h] according to different test modes

Mode	1	2	3	4	5	6
CO _{2mass}	9 354,488	7 295,794	5 717,531	3 973,503	2 756,113	1 430,229

2.3.6. Specific emissions

The specific emission (g/kWh) shall be calculated for all individual components:

$$\text{Individual gas} = \frac{\sum_{i=1}^n (\text{Gas}_{mass_i} \times \text{WF}_i)}{\sum_{i=1}^n (P_i \times \text{WF}_i)}$$

Table 26 — Emissions [g/h] and weighting factors according to different test modes

Mode		1	2	3	4	5	6
HC _{mass}	g/h	25,666	25,993	21,607	21,850	34,074	48,963
NO _{xmass}	g/h	67,168	38,721	19,012	4,621	2,319	0,811
CO _{mass}	g/h	2 188,001	2 068,760	1 510,187	1 424,792	1 853,109	975,435
CO _{2mass}	g/h	9 354,488	7 295,794	5 717,531	3 973,503	2 756,113	1 430,229
Power P _i	kW	13,15	9,81	6,52	3,25	1,28	0
Weighting factors WF _i	—	0,090	0,200	0,290	0,300	0,070	0,050

$$HC = \frac{25,666 \times 0,090 + 25,993 \times 0,200 + 21,607 \times 0,290 + 21,850 \times 0,300 + 34,074 \times 0,070 + 48,963 \times 0,050}{13,15 \times 0,090 + 9,81 \times 0,200 + 6,52 \times 0,290 + 3,25 \times 0,300 + 1,28 \times 0,070 + 0 \times 0,050} = 4,12 \text{ g/kWh}$$

$$NO_x = \frac{67,168 \times 0,090 + 38,721 \times 0,200 + 19,012 \times 0,290 + 4,621 \times 0,300 + 2,319 \times 0,070 + 0,811 \times 0,050}{13,15 \times 0,090 + 9,81 \times 0,200 + 6,52 \times 0,290 + 3,25 \times 0,300 + 1,28 \times 0,070 + 0 \times 0,050} = 3,42 \text{ g/kWh}$$

$$CO = \frac{2\,188,001 \times 0,09 + 2\,068,760 \times 0,2 + 1\,510,187 \times 0,29 + 1\,424,792 \times 0,3 + 1\,853,109 \times 0,07 + 975,435 \times 0,05}{13,15 \times 0,090 + 9,81 \times 0,200 + 6,52 \times 0,290 + 3,25 \times 0,300 + 1,28 \times 0,070 + 0 \times 0,050} = 271,15 \text{ g/kWh}$$

$$CO_2 = \frac{9\,354,488 \times 0,09 + 7\,295,794 \times 0,2 + 5\,717,531 \times 0,29 + 3\,973,503 \times 0,3 + 2\,756,113 \times 0,07 + 1\,430,229 \times 0,05}{13,15 \times 0,090 + 9,81 \times 0,200 + 6,52 \times 0,290 + 3,25 \times 0,300 + 1,28 \times 0,070 + 0 \times 0,050} = 887,53 \text{ g/kWh}$$

Appendix 4

1. COMPLIANCE WITH EMISSION STANDARDS

This Appendix shall apply to SI engines stage 2 only.

- 1.1. The exhaust emission standards for stage 2 engines in Annex I (4.2) apply to the emissions of the engines for their emission durability period EDP as determined in accordance with this Appendix.
- 1.2. For all stage 2 engines, if, when properly tested according to the procedures in this Directive, all test engines representing an engine family have emissions which, when adjusted by multiplication by the deterioration factor (DF) laid down in this Appendix, are less than or equal to each stage 2 emission standard (family emission limit (FEL), where applicable) for a given engine class, that family shall be considered to comply with the emission standards for that engine class. If any test engine representing an engine family has emissions which, when adjusted by multiplication by the deterioration factor laid down in this Appendix, are greater than any single emission standard (FEL, where applicable) for a given engine class, that family shall be considered not to comply with the emission standards for that engine class.
- 1.3. Small volume engine manufacturers may, optionally, take deterioration factors for HC+NO_x and CO from table 1 or 2 in this section, or they may calculate deterioration factors for HC+NO_x and CO according to the process described in section 1.3.1. For technologies not covered by tables 1 and 2 in this section, the manufacturer must use the process described in section 1.4 in this Appendix.

Table 1: Hand-held engine HC+NO_x and CO assigned deterioration factors for small volume manufacturer

Engine class	Two-stroke engines		Four-stroke engines		Engines with after treatment
	HC + NO _x	CO	HC + NO _x	CO	
SH:1	1,1	1,1	1,5	1,1	DFs must be calculated using the formula in section 1.3.1
SH:2	1,1	1,1	1,5	1,1	
SH:3	1,1	1,1	1,5	1,1	

Table 2: Non-hand-held engine HC+NO_x and CO assigned deterioration factors for small volume manufacturers

Engine Class	Side Valve Engines		Overhead Valve Engines		Engines with after treatment
	HC + NO _x	CO	HC + NO _x	CO	
SN:1	2,1	1,1	1,5	1,1	DFs must be calculated using the formula in section 1.3.1
SN:2	2,1	1,1	1,5	1,1	
SN:3	2,1	1,1	1,5	1,1	
SN:4	1,6	1,1	1,4	1,1	

1.3.1. *Formula for calculating deterioration factors for engines with after treatment:*

$$DF = [(NE * EDF) - (CC * F)] / (NE - CC)$$

where:

DF = deterioration factor

NE = new engine emission levels prior to the catalyst (g/kWh)

EDF = deterioration factor for engines without catalyst as shown in table 1

CC = amount converted at 0 hours in g/kWh

F = 0,8 for HC and 0,0 for NO_x for all classes of engines

F = 0,8 for CO for all classes of engines

1.4. Manufacturers shall obtain an assigned DF or calculate a DF, as appropriate, for each regulated pollutant for all stage 2 engine families. Such DFs shall be used for type approval and production line testing.

1.4.1. For engines not using assigned DFs from tables 1 or 2 of this section, DFs shall be determined as follows:

1.4.1.1. On at least one test engine representing the configuration chosen to be the most likely to exceed HC + NO_x emission standards, (FELs where applicable), and constructed to be representative of production engines, conduct (full) test procedure emission testing as described in this Directive after the number of hours representing stabilised emissions.

1.4.1.2. If more than one engine is tested, average the results and round to the same number of decimal places contained in the applicable standard, expressed to one additional significant figure.

1.4.1.3. Conduct such emission testing again following ageing of the engine. The ageing procedure should be designed to allow the manufacturer to appropriately predict the in-use emission deterioration expected over the durability period of the engine, taking into account the type of wear and other deterioration mechanisms expected under typical consumer use which could affect emissions performance. If more than one engine is tested, average the results and round to the same number of decimal places contained in the applicable standard, expressed to one additional significant figure.

1.4.1.4. Divide the emissions at the end of the durability period (average emissions, if applicable) for each regulated pollutant by the stabilised emissions (average emissions, if applicable) and round to two significant figures. The resulting number shall be the DF, unless it is less than 1,00, in which case the DF shall be 1,0.

1.4.1.5. At the manufacturer's option additional emission test points can be scheduled between the stabilised emission test point and the emission durability period. If intermediate tests are scheduled, the test points must be evenly spaced over the EDP (plus or minus two hours) and one such test point shall be at one half of full EDP (plus or minus two hours).

For each pollutant HC + NO_x and CO, a straight line must be fitted to the data points treating the initial test as occurring at hour zero, and using the method of least-squares. The deterioration factor is the calculated emissions at the end of the durability period divided by the calculated emissions at zero hours.

1.4.1.6. Calculated deterioration factors may cover families in addition to the one on which they were generated if the manufacturer submits a justification acceptable to the national type approval authority in advance of type approval that the affected engine families can be reasonably expected to have similar emission deterioration characteristic based on the design and technology used.

A non-exclusive list of design and technology groupings is given below:

- conventional two-stroke engines without after treatment system,
- conventional two-stroke engines with a ceramic catalyst of the same active material and loading, and the same number of cells per cm²,
- conventional two-stroke engines with a metallic catalyst of the same active material and loading, same substrate and the same number of cells per cm²,
- two-stroke engines provided with a stratified scavenging system,
- four-stroke engines with catalyst (defined as above) with same valve technology and identical lubrication system,
- four-stroke engines without catalyst with the same valve technology and identical lubrication system.

2. EMISSION DURABILITY PERIODS FOR STAGE 2 ENGINES

2.1. Manufacturers shall declare the applicable EDP category for each engine family at the time of type approval. Such category shall be the category which most closely approximates the expected useful lives of the equipment into which the engines are expected to be installed as determined by the engine manufacturer. Manufacturers shall retain data appropriate to support their choice of EDP category for each engine family. Such data shall be supplied to the approval authority upon request.

2.1.1. For hand-held engines: manufacturers shall select an EDP category from table 1.

Table 1: EDP categories for hand-held engines (hours)

Category	1	2	3
Class SH:1	50	125	300
Class SH:2	50	125	300
Class SH:3	50	125	300

2.1.2. For non-hand-held engines: manufacturers shall select an EDP category from table 2.

Table 2: EDP categories for non-hand-held engines (hours)

Category	1	2	3
Class SN:1	50	125	300
Class SN:2	125	250	500
Class SN:3	125	250	500
Class SN:4	250	500	1 000

2.1.3. The manufacturer must satisfy the approval authority that the declared useful life is appropriate. Data to support a manufacturer's choice of EDP category, for a given engine family, may include but are not limited to:

- surveys of the life spans of the equipment in which the subject engines are installed,
- engineering evaluations of field aged engines to ascertain when engine performance deteriorates to the point where usefulness and/or reliability is impacted to a degree sufficient to necessitate overhaul or replacement,

- warranty statements and warranty periods,
- marketing materials regarding engine life,
- failure reports from engine customers, and
- engineering evaluations of the durability, in hours, of specific engine technologies, engine materials or engine designs.'

5. Annex IV shall become Annex V and shall be amended as follows:

The current headings shall be replaced by the following:

TECHNICAL CHARACTERISTICS OF REFERENCE FUEL PRESCRIBED FOR APPROVAL TESTS AND TO VERIFY CONFORMITY OF PRODUCTION

NON-ROAD MOBILE MACHINERY REFERENCE FUEL FOR CI ENGINES (1)

In the table in the line on 'Neutralisation' the word 'Minimum' in column 2 shall be replaced by the word 'Maximum'. The following new table and new footnotes shall be added:

NON-ROAD MOBILE MACHINERY REFERENCE FUEL FOR SI ENGINES

Note: The fuel for two-stroke engines is a blend of lubricant oil and the petrol specified below. The fuel/oil mixture ratio must be the ratio which is recommended by the manufacturer as specified in Annex IV, section 2.7.

Parameter	Unit	Limits ⁽¹⁾		Test method	Publication
		Minimum	Maximum		
Research octane number, RON		95,0	—	EN 25164	1993
Motor octane number, MON		85,0	—	EN 25163	1993
Density at 15 °C	kg/m ₃	748	762	ISO 3675	1995
Reid vapour pressure	kPa	56,0	60,0	EN 12	1993
Distillation			—		
Initial boiling point	°C	24	40	EN-ISO 3405	1988
— Evaporated at 100 °C	% v/v	49,0	57,0	EN-ISO 3405	1988
— Evaporated at 150 °C	% v/v	81,0	87,0	EN-ISO 3405	1988
— Final boiling point	°C	190	215	EN-ISO 3405	1988
Residue	%	—	2	EN-ISO 3405	1988
Hydrocarbon analysis	—				—
— Olefins	% v/v	—	10	ASTM D 1319	1995
— Aromatics	% v/v	28,0	40,0	ASTM D 1319	1995
— Benzene	% v/v	—	1,0	EN 12177	1998
— Saturates	% v/v	—	balance	ASTM D 1319	1995
Carbon/hydrogen ratio		report	report		
Oxidation stability ⁽²⁾	min.	480	—	EN-ISO 7536	1996
Oxygen content	% m/m	—	2,3	EN 1601	1997

Parameter	Unit	Limits ⁽¹⁾		Test method	Publication
		Minimum	Maximum		
Existent gum	mg/ml	—	0,04	EN-ISO 6246	1997
Sulphur content	mg/kg	—	100	EN-ISO 14596	1998
Copper corrosion at 50 °C		—	1	EN-ISO 2160	1995
Lead content	g/l	—	0,005	EN 237	1996
Phosphorus content	g/l	—	0,0013	ASTM D 3231	1994

Note 1: The values quoted in the specification are "true values". In establishment of their limit values the terms of ISO 4259 "Petroleum products — Determination and application of precision data in relation to methods of test" have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility). Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuels should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

Note 2: The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilise refinery gasoline streams, but detergent/dispersive additives and solvent oils must not be added.'

6. Annex V shall become Annex VI.
7. Annex VI shall become Annex VII and shall be amended as follows:
- (a) Appendix 1 shall be amended as follows:

— The heading shall be replaced by the following:

'Appendix 1

TEST RESULTS FOR COMPRESSION IGNITION ENGINES'

— section 1.3.2 shall be replaced by the following:

'1.3.2. Power absorbed at indicated engine speed (as specified by the manufacturer):

Equipment	Power P_{AE} (kW) absorbed at various engine speeds (*), taking into account Appendix 3 of this Annex	
	Intermediate (if applicable)	Rated
Total		

(*) Must not be greater than 10 % of the power measured during the test.'

— section 1.4.2 shall be replaced by the following:

1.4.2. Engine power (*)

Condition	Power setting (kW) at various engine speeds	
	Intermediate (if applicable)	Rated
Maximum power measured on test (P_M) (kW) (a)		
Total power absorbed by engine driven equipment as per section 1.3.2 of this Appendix, or section 2.8 of Annex III (P_{AE}) (kW) (b)		
Net engine power as specified in section 2.4 of Annex I (kW) (c)		
$c = a + b$		

(*) Uncorrected power measured in accordance with the provisions of section 2.4 of Annex I.

— section 1.5 shall be amended as follows:

1.5. Emission levels

1.5.1. Dynamometer setting (kW)

Percent Load	Dynamometer setting (kW) at various engine speeds	
	Intermediate (if applicable)	Rated
10 (if applicable)		
25 (if applicable)		
50		
75		
100		

1.5.2. Emission results on the test cycle*:

(b) The following Appendix shall be added:

Appendix 2

TEST RESULTS FOR SPARK IGNITION ENGINES

1. INFORMATION CONCERNING THE CONDUCT OF THE TEST(S) (*):

1.1. **Octane number**

1.1.1. Octane number:

1.1.2. State percentage of oil in mixture when lubricant and petrol are mixed as in the case of two-stroke engines

1.1.3. Density of petrol for four-stroke engines and petrol/oil mixture for two-stroke engines

(*) In case of several parent engines, to be indicated for each of them.

1.2. **Lubricant**

1.2.1. Make(s)

1.2.2. Type(s)

1.3. **Engine driven equipment (if applicable)**

1.3.1. Enumeration and identifying details

1.3.2. Power absorbed at indicated engine speed (as specified by the manufacturer)

Equipment	Power P_{AE} (kW) absorbed at various engine speeds (*), taking into account Appendix 3 of this Annex	
	Equipment	Rated
Total		

(*) Must not be greater than 10 % of the power measured during the test.

1.4. **Engine performance**

1.4.1. Engine speeds:

Idle: min^{-1} Intermediate: min^{-1} Rated: min^{-1}

1.4.2. Engine power (*)

Condition	Power setting (kW) at various engine speeds	
	Intermediate (if applicable)	Rated
Maximum power measured on test (P_M) (kW) (a)		
Total power absorbed by engine driven equipment as per section 1.3.2 of this Appendix, or section 2.8 of Annex III (P_{AE}) (kW) (b)		
Net engine power as specified in section 2.4 of Annex I (kW) (c)		
$c = a + b$		

(*) Uncorrected power measured in accordance with the provisions of section 2.4 of Annex I.

1.5. **Emission levels**

1.5.1. Dynamometer setting (kW)

Percent Load	Dynamometer setting (kW) at various engine speeds	
	Intermediate (if applicable)	Rated (if applicable)
10 (if applicable)		
25 (if applicable)		
50		
75		
100		

1.5.2. Emission results on the test cycle:

CO: g/kWh

HC: g/kWh

NO_x: g/kWh'

(c) The following Appendix 3 shall be added:

'Appendix 3

EQUIPMENT AND AUXILIARIES TO BE INSTALLED FOR THE TEST TO DETERMINE ENGINE POWER

Number	Equipment and auxiliaries	Fitted for emission test
1	Inlet system Inlet manifold Crankcase emission control system Control devices for dual induction inlet manifold system Air flow meter Air inlet duct work Air filter Inlet silencer Speed-limiting device	Yes, standard production equipment Yes, standard production equipment Yes, standard production equipment Yes, standard production equipment Yes (a) Yes (a) Yes (a) Yes (a)
2	Induction-heating device of inlet manifold	Yes, standard production equipment. If possible to be set in the most favourable condition
3	Exhaust system Exhaust purifier Exhaust manifold Connecting pipes Silencer Tail pipe Exhaust brake Pressure charging device	Yes, standard production equipment Yes, standard production equipment Yes (b) Yes (b) Yes (b) No (c) Yes, standard production equipment

Number	Equipment and auxiliaries	Fitted for emission test
4	Fuel supply pump	Yes, standard production equipment ^(d)
5	Carburation equipment	
	Carburettor	Yes, standard production equipment
	Electronic control system, air flow meter, etc.	Yes, standard production equipment
	Equipment for gas engines	
	Pressure reducer	Yes, standard production equipment
	Evaporator	Yes, standard production equipment
	Mixer	Yes, standard production equipment
6	Fuel injection equipment (petrol and diesel)	
	Prefilter	Yes, standard production or test bed equipment
	Filter	Yes, standard production or test bed equipment
	Pump	Yes, standard production equipment
	High-pressure pipe	Yes, standard production equipment
	Injector	Yes, standard production equipment
	Air inlet valve	Yes, standard production equipment ^(e)
	Electronic control system, air flow meter, etc.	Yes, standard production equipment
	Governor/control system	Yes, standard production equipment
	Automatic full-load stop for the control rack depending on atmospheric conditions	Yes, standard production equipment
7	Liquid-cooling equipment	
	Radiator	No
	Fan	No
	Fan cowl	No
	Water pump	Yes, standard production equipment ^(f)
	Thermostat	Yes, standard production equipment ^(g)
8	Air cooling	
	Cowl	No ^(h)
	Fan or Blower	No ^(h)
	Temperature-regulating device	No
9	Electrical equipment	
	Generator	Yes, standard production equipment ⁽ⁱ⁾
	Spark distribution system	Yes, standard production equipment
	Coil or coils	Yes, standard production equipment
	Wiring	Yes, standard production equipment
	Spark plugs	Yes, standard production equipment
	Electronic control system including knock sensor/spark retard system	Yes, standard production equipment

Number	Equipment and auxiliaries	Fitted for emission test
10	Pressure charging equipment	
	Compressor driven either directly by the engine and/or by the exhaust gases	Yes, standard production equipment
	Charge air cooler	Yes, standard production or test bed equipment (f) (k)
	Coolant pump or fan (engine-driven)	No (h)
	Coolant flow control device	Yes, standard production equipment
11	Auxiliary test-bed fan	Yes, if necessary
12	Anti-pollution device	Yes, standard production equipment (l)
13	Starting equipment	Test bed equipment
14	Lubricating oil pump	Yes, standard production equipment

- (a) The complete inlet system shall be fitted as provided for the intended application: where there is a risk of an appreciable effect on the engine power; in the case of naturally aspirated spark ignition engines; when the manufacturer requests that this should be done. In other cases, an equivalent system may be used and a check should be made to ascertain that the intake pressure does not differ by more than 100 Pa from the upper limit specified by the manufacturer for a clean air filter.
- (b) The complete exhaust system shall be fitted as provided for the intended application: where there is a risk of an appreciable effect on the engine power; in the case of naturally aspirated spark ignition engines; when the manufacturer requests that this should be done. In other cases, an equivalent system may be installed provided the pressure measured does not differ by more than 1 000 Pa from the upper limit specified by the manufacturer.
- (c) If an exhaust brake is incorporated in the engine, the throttle valve shall be fixed in the fully open position.
- (d) The fuel feed pressure may be adjusted, if necessary, to reproduce the pressure existing in the particular engine application (particularly when a "fuel return" system is used).
- (e) The air intake valve is the control valve for the pneumatic governor of the injection pump. The governor or the fuel injection equipment may contain other devices which may affect the amount of injected fuel.
- (f) The cooling-liquid circulation shall be operated by the engine water pump only. Cooling of the liquid may be produced by an external circuit, such that the pressure loss of this circuit and the pressure at the pump inlet remain substantially the same as those of the engine cooling system.
- (g) The thermostat may be fixed in the fully open position.
- (h) When the cooling fan or blower is fitted for the test, the power absorbed shall be added to the results, except for cooling fans of air cooled engines directly fitted on the crankshaft. The fan or blower power shall be determined at the speeds used for the test either by calculation from standard characteristics or by practical tests.
- (i) Minimum power of the generator: the electrical power of the generator shall be limited to that necessary for operation of accessories which are indispensable for engine operation. If the connection of a battery is necessary, a fully charged battery in good condition shall be used.
- (j) Charge air-cooled engines shall be tested with charge air cooling, whether liquid- or air-cooled, but if the manufacturer prefers, a test bench system may replace the air cooler. In either case, the measurement of power at each speed shall be made with the maximum pressure drop and the minimum temperature drop of the engine air across the charge air cooler on the test bench system as specified by the manufacturer.
- (k) These may include, for example, exhaust-gas recirculation (EGR)-system, catalytic converter, thermal reactor, secondary air-supply system and fuel evaporation protecting system.
- (l) The power for electrical or other starting systems shall be provided from the test bed.'

8. Annexes VII to X shall become Annexes VIII to XI.
9. The following Annex shall be added:

'ANNEX XII

RECOGNITION OF ALTERNATIVE TYPE-APPROVALS

1. The following type-approvals and, where applicable, the pertaining approval marks are recognised as being equivalent to an approval to this Directive for engines of categories A, B and C as defined in Article 9(2):
 - 1.1. Directive 2000/25/EC.
 - 1.2. Type-approvals to Directive 88/77/EEC, complying with the requirements of stage A or B regarding Article 2 and Annex I, section 6.2.1 of Directive 88/77/EEC as amended by Directive 91/542/EEC, or UN-ECE Regulation 49.02 series of amendments corrigenda 1/2.
 - 1.3. Certificates of type approvals according to UN-ECE Regulation 96.
 2. For engines categories D, E, F and G (stage II) as defined in Article 9(3), the following type-approvals and, where applicable, the pertaining approval marks are recognised as being equivalent to an approval to this Directive:
 - 2.1. Directive 2000/25/EC, stage II approvals;
 - 2.2. Type-approvals to Directive 88/77/EEC as amended by Directive 99/96/EC which are in compliance with stages A, B1, B2 or C provided for in Article 2 and section 6.2.1 of Annex I;
 - 2.3. UN-ECE Regulation 49.03 series of amendments;
 - 2.4. UN-ECE Regulation 96 stage B approvals according to paragraph 5.2.1 of the 01 series of amendments of Regulation 96.
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