

COMPARISON OF TEST STANDARDS FROM VARIOUS COUNTRIES

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Introduction

Standards for testing of wood fired applications have been introduced from several **countries/states**. However, these standards have different goals and philosophy. In this paper standards from seven countries/states are discussed briefly. In the discussion there have been focused on the emissions even if the standards also may include other topics. The standards are from Sweden, Denmark, Germany, USA, Canada, Australia and Norway.

SP-method 107 1 (Sweden)

The SP-method 1071 is taking over after the SP-method 0010 and is very close up to it. However, SP-method 1071 also including safety aspects. In this paper there will only be taken notice to the emissions and how to measure it.

The method is made for certification of wood fired stoves, closed fireplaces and ceramic stoves. There are testing for air leakage, particles and tar. The emission testing is done at normal combustion conditions which means:

- * wood at 18% \pm 3% moisture content
- * the firing is done after the specifications by the manufacturer
- * if firing specifications are not given the firing are done with wood loadings of 75% **from** the following equation

$$Y=0.027*X + 1.2$$

Y- is the loading in kg

X- is the combustion chambers size in dm^3

- * loading of wood should be done when the CO_2 concentration in the chimney goes below 4%
- * adjustments of the air supply should be done in a way which gives loadings every 50 minutes \pm 5 minutes
- * testing of tar and particles starts after the first loading of wood

* the testing should contain at least 3 loadings of wood and the **test** gas should be at least 3 normal m^3

A schematic drawing of the sampling train for measuring tar and particles are given in figure 1. The particles are only collected in the filter (number 3 in figure 1) and the tar also from the **XAD**- filter and the tubes. **Types** of measurements are given in table 1. The restrictions are given to the **tar** and the amount should not be higher than 40 **mg/MJ** input.

The particle measured after the SP-method 1071 can not be compared with the particle measured for instant after the EPA (Environmental Protection Agency) method 5G (used in the UAS). Not only **because** of big differences in the firing procedures but also because of the big difference in temperature in the filter were the particles are collected. If any comparison should be **done** between **the SP-method** 1071 and the EPA method 5G it must be the amount of tar and particles compared with the amount of particles at same average wood consumption. Even than a difference in results must be expected mainly because of the firing procedures.

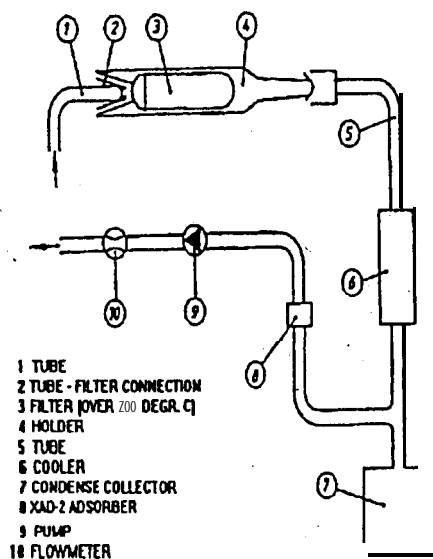


Figure 1. Equipment for testing after SP-method 1071 (Sweden)

DS887-2 (Denmark)

The method DS887-2 is made for testing of closed stoves with nominal effect up to 15 kW. Nominal effect means the nominal effect given by the manufacturer and given from testing. This method is close up to the German method DIN18891 from 1984. A schematic drawing of the testing equipment is given in figure, 2. The restrictions are put on efficiency which should be more than 70% and the CO which should be in **average below 0.3% at a CO₂ concentration of 7.5%**. The method also gives requirements to surface temperatures stability and air leakage. The fuel moisture content should be 18% ± 3%. The method including safety aspects. Results can be compared with the German method DIN18891, but not directly to other methods mention in this paper. Types of measuring are given in table 1.

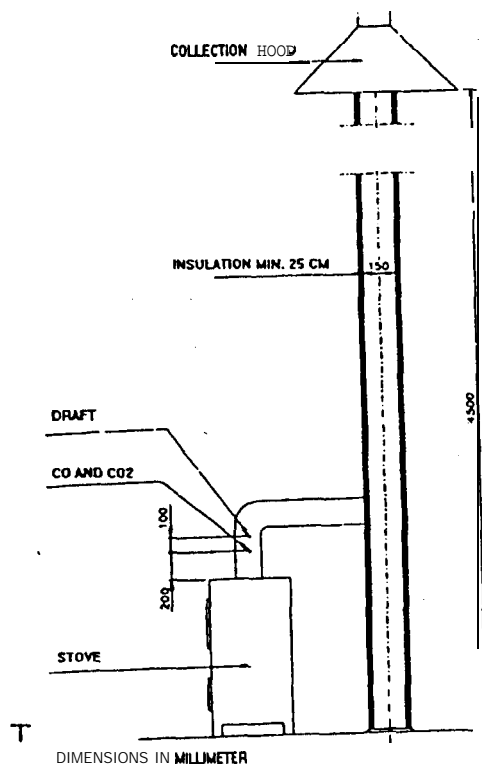


Figure 2. Equipment for testing after DS887-2. (Denmark)

DIN18891 (Germany)

This method is made for testing of stoves fired with solid fuels and with a given heat output up to 11 kW. The method shall not be used for stoves connected to water or for open fireplaces.

If the tested stove or fireplace have a ash basket this one have to be at **'least 0.5 dm³ for each kW** of the given heat output. The restrictions are connected to the efficiency which have to be 70% or better. However, if it is a stove/fireplace with glass surface bigger than 0.2 m² and the air is coming **inn over** the glass surface, the efficiency may be as low as 60%.

The method have also some restrictions such as dampers, leakage surface, door opening, cleaning possibilities, tube sizes and so on. The method also including safety aspects. The testing have to be done by an accepted testing laboratory. The amount of wood consumption **is** measured by weight. Also the loaded wood and the ash shall be measured. In the chimney the CO, and CO + H₂ shall be measured, but no restrictions to the CO,+ H₂ are given.

Types of measuring are given in table 1. The method is close up to the Danish method **DS887-2**, which have been made basicly from this method. Comparisons between DIN18891 and **DS887-2** can **therefor** be done. A schematic drawing of equipment for testing after DIN18891 are given **in figure 3**.

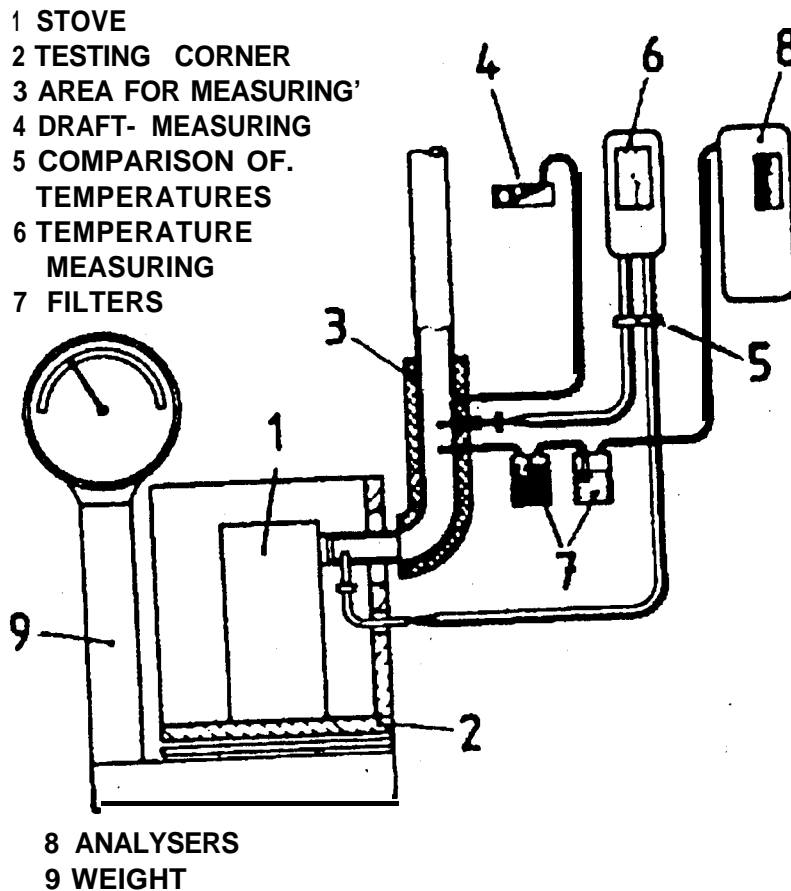


Figure 3. Equipment for testing after DIN18891.
 (Germany)

EPA method 5G (USA)

This method is made for determination of particle emissions from wood heaters. The method is based upon using a dilution tunnel and firing procedures from method 28A. A schematic drawing of the equipment is given in figure 4. The method is very restricted in firing procedures, accuracy and calibrations. For certification there have to be done four runs at different average wood consumptions. More details of the runs and the firing procedures are given in the EPA- method 28A.

By using four different average wood consumptions information about the stove/fireplace from low to high firing rate will be given. This is a big difference from the Swedish, Danish and

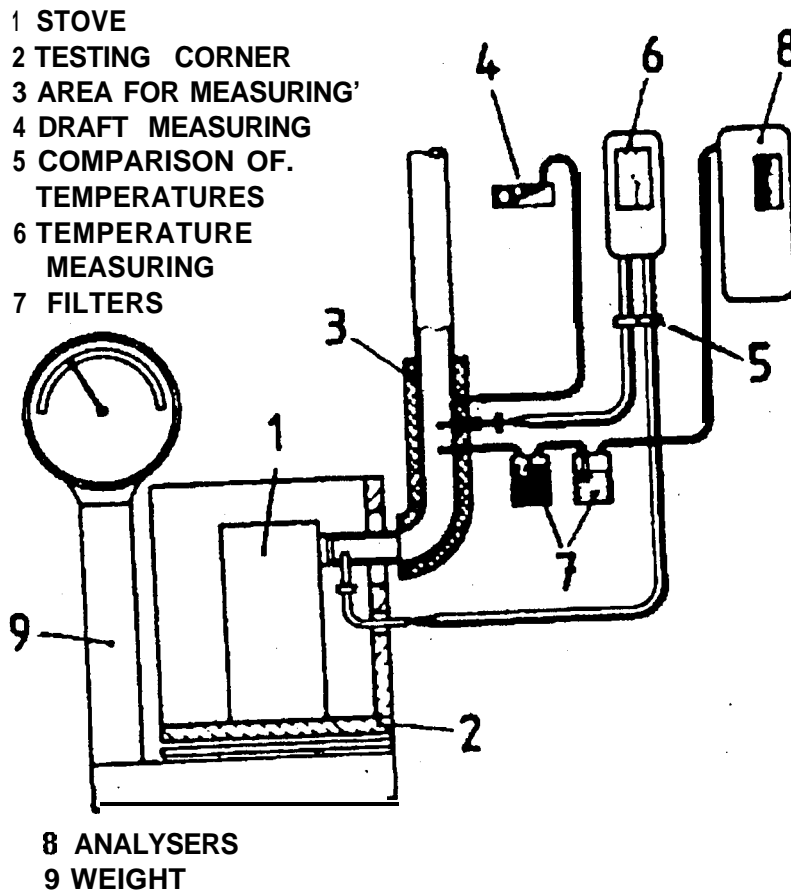


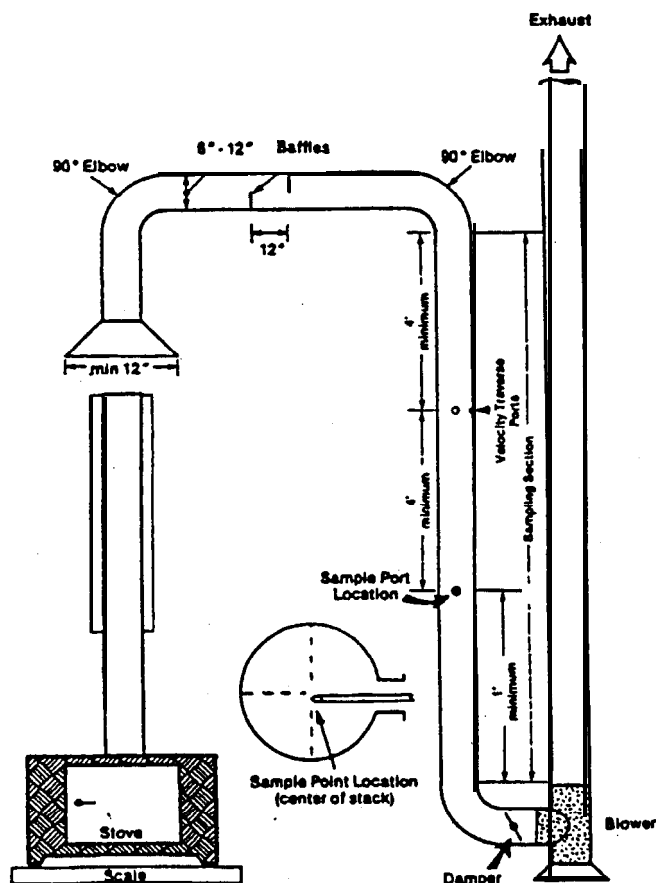
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By using four different average wood consumptions information about the stove/fireplace from low to high firing rate will be given. This is a big difference from the Swedish, Danish and

German methods. From the method four values of particle emissions measured in g/hour at four average wood **consumptions** (less than 0.8, 0.8 - 1.24, 1.25 - 1.9 and more than 1.9 kg/hour) From the four values a total particle emission value is calculated. From 1. July 1990 this value is 4.1 g/hour for catalytic stoves/fireplaces and 7.5 g/hour for none catalytic stoves/fireplaces. In figure 4 a schematic drawing of the testing facilities are given. Types of measurements are given in table 1.



Figure' 4. Equipment for testing after EPA method 5G. (USA)

B415-M 1986 (Canada)

This standard is made for determining heat outputs, appliance efficiency, emission levels and composition, and flue gas flow rats for wood fired appliances with a closed firing chamber.

From the standard we are in this paper focusing on the emissions and how to do the measuring of these. For particle emissions measuring a dilution tunnel is used. The method is close up to the EPA method 5G for particle emissions. However, the burn rates are not necessary the same and there are several small differences in the firing procedures. Since the method is closed up to EPA method 5G and there should not be very big differences in the emission levels at same average wood consumption. A updated version of the method will soon be accepted for particle emission control in Canada. The levels for the emissions will also very soon be given. A schematic drawing of the test facilities are given in figure 5. Types of measurements are given in table 1.

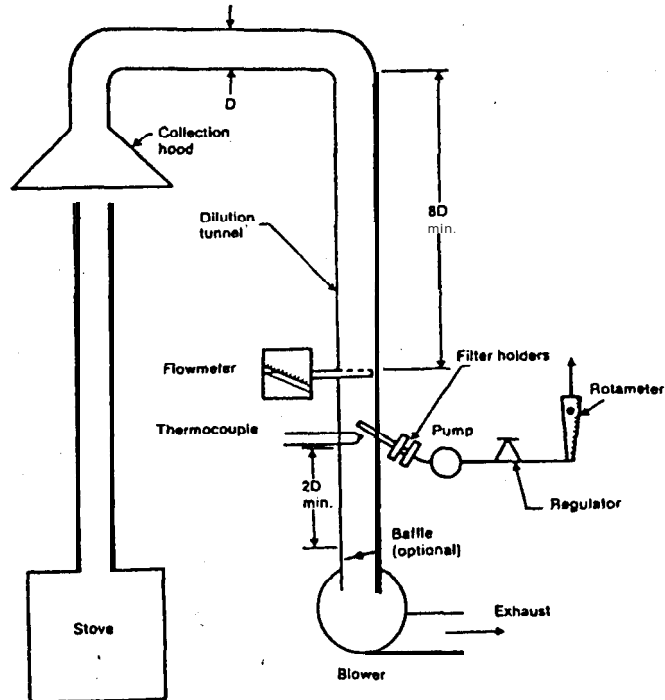


Figure 5. Equipment for testing after B415-M1986. (Canada)

Draft number 91064 (Australia)

The Australians are working with standards for solid fuel combustion appliances- and have worked out a draft for

standards. From' this draft, draft number 91064 will be discussed in this paper. The standard specifies a test method for determining the rate of particulate emission from batch-fed domestic solid fuel burning appliances and the associated particulate emission criteria. In this method we find much common with the EPA- method and the Canadian method, but there can be big differences **in the** fuel loadings and the firing procedures. For comparing emission levels the EPA- methods, the Canadian. methods and the Norwegian methods should be the nearest. However, differences in numbers must be expected.,

The proposal values for particle emissions are 4.0 g/kg fired wood for none catalytic appliances and 2.1 g/kg fired wood for catalytic appliances. This values are based upon an average firing at low, medium and high burn rates. A schematic drawing of the testing facilities are given in figure 6. Types of measurements are given in table 1.

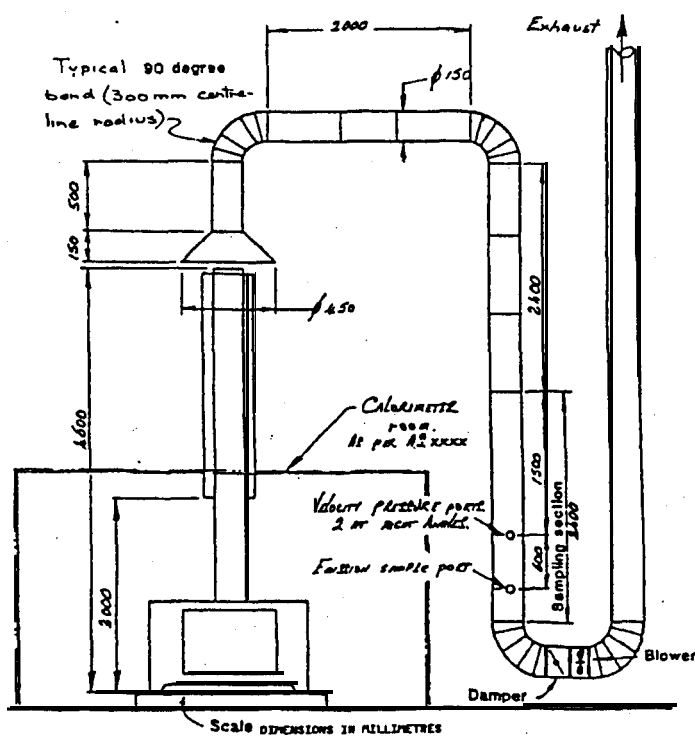


Figure 6. Equipment for testing after Australian draft number 91064. (Australia)

Metode A - D (Norway)

This methods are made for emission testing of wood fired stoves and fireplaces. The methods are close up to the EPA methods. **However**, there are some differences in the fuel and how to calculate the total amount of particles. The method for **firing** procedures are given in **metode A**, measuring of particles in method B, how to measure CO and CO₂ in **metode C** and measuring of PAH in **metode D**.

For certification the restrictions will be put on particle emissions. Big differences in particle emissions at same average wood consumption between this methods and the EPA methods are not expected. The levels for the particle emissions will very soon be given by **Statens Forurensningstilsyn** and is expected to be less than 5 g/kg fired wood for catalytic stoves/fireplaces and 10 g/kg fired wood for stoves/fireplaces without catalytic equipment. This values are based upon four runs from four average wood **consumptions** and a calculation formula based upon firing levels in Norway. A schematic drawing of the testing facilities are given in figure 7. Types of measurings are given in table 1.

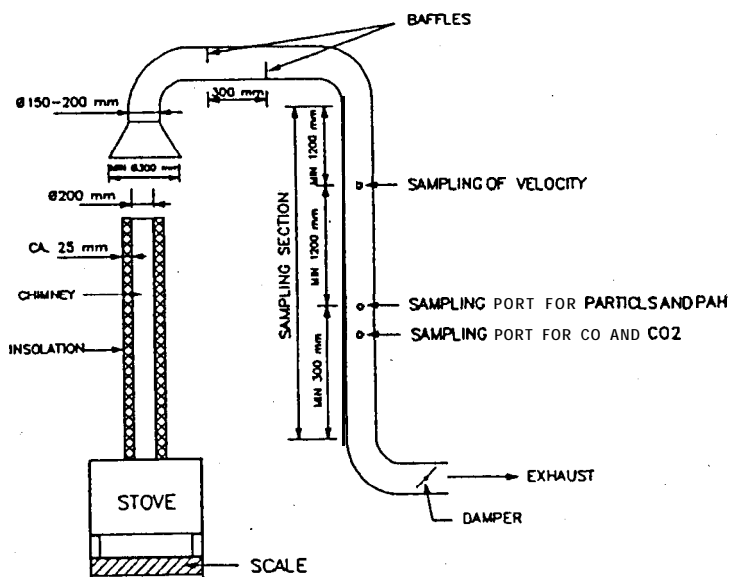


Figure 7. Equipment for testing after method A, B, C and D. (Norway)

FIRING AND MEASUREMENTS IN VARIOUS STANDARDS

	SWEDEN SP-METHOD 107 I	DENMARK DS 887-2	GERMANY DIN 1889 1	USA EPA METHOD 5G	CANADA B4 15-M 1986	AUSTRALIA DRAFT, STANDARD 9 1064	NORWAY METODE A-D
TEMPERATURES	X	X	X	X	X	X	X
CO	X	X			X	X	X
CO ₂	X	X	X		X	X	X
O ₂					X	X	
TAR	X						
DRAFT	X	X	X				X
MOISTURE IN WOOD			X		X	X	X
CO + H ₂			X				
WOOD CONSUMPTION				X	X	X	X
LOADED WOOD, WEIGHT	X	X					
EFFICIENCY		<70%	<70% (60%)				
EXHAUST VELOCITY				X	X	X	X
PARTICLES				X	X	X	X
PAH							X
FIRING PROSEDURE	AS SPECIFIED	NOMINAL EFFECT	NOMINAL EFFECT	FULL LOAD	FUJ. LOAD	AS SPECIFIED	FLU. LOAD
TESTED HEAT OUTPUTS	1	1	1	4	4	3	4
EMISSION LEVELS	>40mg/MJ (TAR)	CO<0.3%, CO ₂ =7.5%	NO LEVEL GIVEN	C 4. 1, NC 7.5 (g/h)	? g/h	c 2.1, NC 4.0 (g/kg)	c ?g/kg, NC ?g/kg

Table 1. Firing and measurement in varios standards.

Conclusions

The standards from the seven countries/states are all different. However, there is several standards which is close up to each other. One **group are** the standards from USA, Canada, Australia and Norway. An other group are the standards from Germany and Denmark. The standard from Sweden have very little in common with any of the other standards. The nearest correlations are **therefor** expected to be found within each of this groups.