



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

What exactly do cigarette smokers inhale?

A comparison between the **WHO Intense method** and the **ISO method**



Introduction

RIVM has measured the amount of tar, nicotine and carbon monoxide (TNCO) in all filter cigarettes sold in the Netherlands with the WHO intense method. The TNCO levels measured with this method were up to 15 times higher than those measured with the legally prescribed ISO method.

When measured with the WHO Intense method, three of the brands had a nicotine level within the legal limit and in all brands the levels of tar and carbon monoxide exceeded the legal limit.

Background

This study was commissioned by the Netherlands Food and Consumer Product Safety Authority (NVWA). It was prompted by a debate about the relevance of the ISO method. The Dutch Tobacco and Related Products Act stipulates this method for measuring TNCO levels in cigarette smoke.

The Youth Smoking Prevention Foundation and others have filed a lawsuit asking the NVWA to take action against cigarettes 'rigged' in this way. They claim that smokers inhale much more TNCO per cigarette than the amounts measured with the ISO method. This is because the legally prescribed method does not take into account the ventilation

holes that manufactures put in cigarette filters. The current law states that cigarette smoke may contain a maximum of 10 mg tar, 1 mg nicotine and 10 mg carbon monoxide. However, the ISO method underestimates the actual TNCO levels cigarette smoke contains and thus inhaled by smokers.¹ This is because smokers take larger and more frequent puffs from their cigarettes than performed with this method. Smokers also block the ventilation holes when smoking.

The NVWA requested RIVM to measure the TNCO levels in the smoke of filter cigarettes sold in the Netherlands using the WHO Intense method.

ISO method and WHO Intense method

The ISO (International Organization for Standardization) method and the WHO (World Health Organization) Intense method smoke cigarettes in a different way. The WHO Intense method simulates more intense smoking behaviour: the machine takes larger and more frequent puffs from the cigarette than the ISO method. Furthermore, the ventilation holes in the filter (Figure 1) are blocked when using the WHO Intense method (Figure 2). These holes are often located at the position where a smoker normally holds the cigarette. This is also what happens during smoking: the smoker blocks the ventilation holes in the filter when the cigarette is held between her/his fingers or lips.² By blocking the

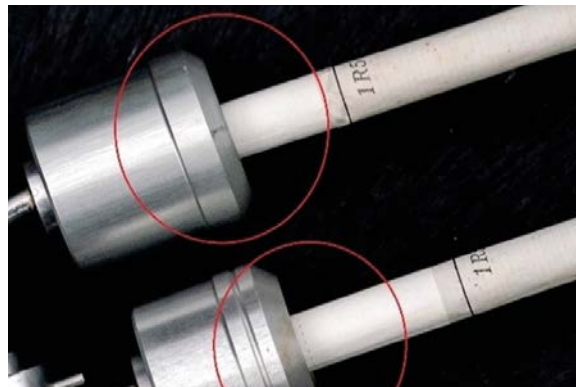
holes and taking larger and more frequent puffs, higher levels of TNCO are measured in the smoke of cigarettes when the WHO intense method is used. The difference between the ISO method and the WHO Intense method is largest for cigarettes with many ventilation holes.

RIVM measured the TNCO levels in all filter cigarettes sold in the Netherlands with the WHO Intense method. For this study, we tested 20 cigarettes from each brand and compared the average results of these 20 cigarettes with the TNCO levels measured with the ISO method that were entered into the European database by the manufacturer or importer.

Figure 1. Ventilation holes in the filter of a cigarette



Figure 2. Cigarette holders for the smoking machine



Top holder: WHO Intense holder
Bottom holder: ISO holder

Higher TNCO levels with the WHO Intense method

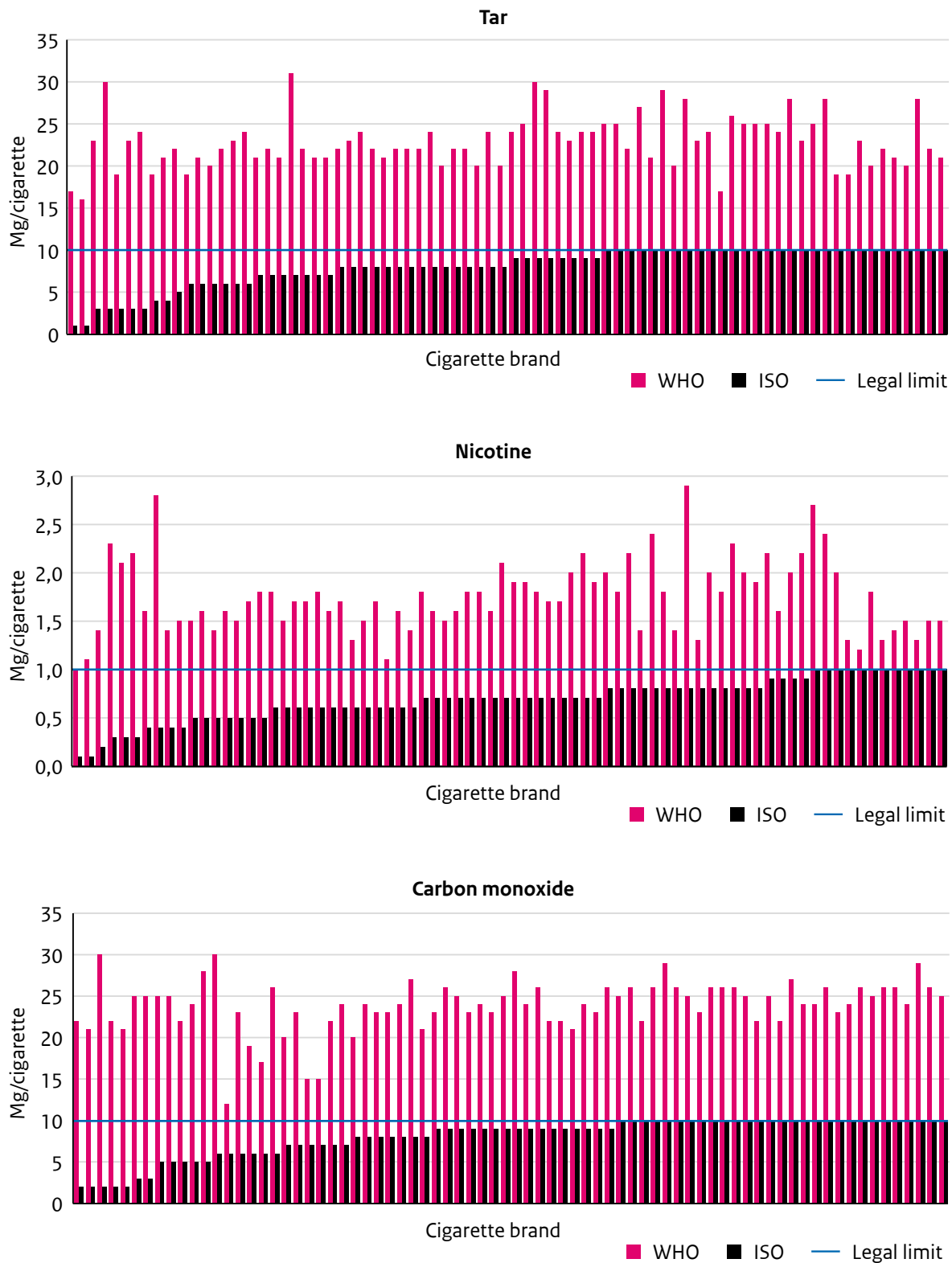
The TNCO levels measured with the WHO Intense method were all higher than those measured with the ISO method. The levels were 1.7 to 17 times higher for tar, 1.2 to 11 times higher for nicotine and 2.0 to 15 times higher for carbon monoxide. These findings are in line with the results of previous studies.^{3,4} The various levels are shown in Table 1 and Figure 3.

As well as in the previous studies, the largest differences between the two measurement methods were found in cigarettes which had relatively low TNCO levels when measured with the ISO method. There are also major differences between brands when using the ISO method. These are due to factors such as the ventilation holes in the filter. Because the

WHO Intense method blocks these holes, the filter holes have no impact on the measurement results. The differences in TNCO levels between brands are therefore smaller than with the ISO method.

To determine whether the levels measured corresponded to the legally permitted maximum levels, measurement uncertainty was taken into account. The amount of tar and carbon monoxide does not meet the legally permitted maximum if the result is above 12 mg per cigarette. For nicotine, the maximum is 1.2 mg per cigarette. Under these criteria, three brands had a nicotine level within the legal limit, despite this level being higher than 1 mg per cigarette. None of the cigarette brands were within the legal limit for tar and carbon monoxide.

Figure 3. Tar, nicotine and carbon monoxide levels as measured with the WHO Intense method (in pink) and the reported levels measured with the ISO method (in black). Each bar shows the average levels in the smoke of 20 cigarettes from the same brand. The blue horizontal line indicates the legally permitted maximum.



Conclusions and recommendations

When measured with the WHO Intense method, the smoke from cigarettes of all brands contained more tar, nicotine and carbon monoxide than the amounts measured by the manufacturer with the ISO method.

In all brands, the levels of tar and carbon monoxide measured with the WHO Intense method exceeded the legal limit. In three of the brands tested, the level of nicotine measured with the WHO Intense method was within the legal limit.

The findings of this study are in line with the results of previous studies.⁴ These also showed that much higher TNCO levels were found using the WHO Intense method compared with the ISO method.

RIVM believes the WHO Intense method (WHO TobLabNet official method SOP 01)⁵ should be included in the law. This method more closely mimics smokers' behaviour than the ISO method.

Literature

1. Martin J. Jarvis, Richard Boreham, Paola Primatesta, Colin Feyerabend, Andrew Bryant. Nicotine Yield From Machine-Smoked Cigarettes and Nicotine Intakes in Smokers: Evidence From a Representative Population Survey. Journal of the National Cancer Institute, Vol. 93, No. 2, January 17, 2001
2. Characteristics of the ISO method and WHO Intense method (in Dutch). (www.rivm.nl/tabak/wat-zit-er-inrook/Kenmerken-ISO-methode-en-WHOIntense-methode)
3. RIVM measures much higher levels of tar, nicotine and carbon monoxide in cigarettes. (www.rivm.nl/en/news/rivm-measures-much-higher-levels-of-tar-nicotine-and-carbon-monoxide-in-cigarettes)
4. Fact sheet: Methods for determining TNCO in tobacco smoke. (www.rivm.nl/sites/default/files/2021-06/Factsheet%20Methods%20of%20determining%20TNCO%20in%20tobacco%20smoke.pdf)
5. WHO TobLabNet official method SOP 01: Standard operating procedure for intense smoking of cigarettes. (https://apps.who.int/iris/handle/10665/75261?search-result=true&query=toblabnet&scope=&rpp=10&sort_by=score&order=desc&page=3)

Table 1. TNCO emissions from filter cigarettes measured with the WHO Intense method (average of 20 cigarettes) and the levels entered into the EU database by the tobacco manufacturer, as measured with the ISO method

Cigarette brand/type	WHO TobLabNet Intense method – levels measured			ISO method – levels entered into the EU database		
	Tar (mg/cig)	Nicotine (mg/cig)	CO (mg/cig)	Tar (mg/cig)	Nicotine (mg/cig)	CO (mg/sig)
Davidoff classic	24	2.0	25	9 - 10	0.8 - 0.9	10
Pall Mall Red XXL	25	1.8	26	10	0.8	10
Bastos	25	2.2	20	10	0.9	8
Davidoff Gold	22	1.6	25	5	0.4	5
Lucky strike Amber L	22	1.8	23	8	0.6	9
Dunhill Red L	22	1.6	22	10	0.9	10
Lambert & Butler silver	27	2.2	26	10	0.8	10
Davidoff Evolved Green	23	1.8	24	8	0.7	8
Gauloises Blondes Gold	19	1.5	20	6	0.5	7
Gauloises Blondes Red Giga	21	1.5	23	7 - 8	0.6	7 - 9
Superkings original	29	2.4	29	10	0.8	10
Pall Mall Alpine L	24	1.7	26	8 - 10	0.6 - 0.7	9 - 10
Lucky Strike BrownRed L	25	1.8	25	9	0.8	9
JPS Blue Maxi	22	1.6	23	8	0.7	8
Camel Blue	21	1.7	23	8	0.6 - 0.7	9
Camel Activate Blue Box	22	1.5	24	8	0.7	9
Voque Bleu Originale L	22	1.6	25	7	0.5 - 0.7	5 - 8
Camel Activate Green	22	1.6	23	8	0.7	9
JPS Fresh	22	1.8	23	8	0.7	8
PallMall Blue XXL	21	1.4	24	7 - 9	0.5 - 0.7	8 - 9
Karelia S original	31	2.9	30	7	0.8	6
L&M Red	28	1.8	26	10	0.7	10
Marlboro prime	17	1.0	22	1	0.1	2
Karelia S blue	23	2.3	21	3	0.3	2
Karelia S crème	30	2.8	30	3	0.4	2
JPS Red Giga	23	1.6	25	10	0.7	9
American Spirit Original Blue	30	2.7	28	9	1	9
Davidoff Silver	19	1.4	25	3	0.2	3
Lucky Strike Red XL	29	2.1	27	9 - 10	0.7 - 0.9	8 - 10
Camel Yellow	24	2.0	25	10	0.9	10
Gauloises Blondes Blue	24	1.9	24	9 - 10	0.7 - 0.8	9 - 10
Gauloises Brunas	17	1.3	12	10	0.8	6
LuckyStrike brownblue L	21	1.6	23	6	0.5	6
Kent Surround L	19	1.4	22	4	0.4	5
Dunhill Blonde Flow	21	1.5	24	4	0.4	5
Lucky strike Icecold L	24	1.8	26	8 - 10	0.6 - 0.7	9 - 10

Cigarette brand/type	WHO TobLabNet Intense method – levels measured			ISO method – levels entered into the EU database		
	Tar (mg/cig)	Nicotine (mg/cig)	CO (mg/cig)	Tar (mg/cig)	Nicotine (mg/cig)	CO (mg/sig)
Camel Orange	23	2.0	23	9	0.8	10
Dunhill white flow L	16	1.1	22	1	0.1	2
Winston S-Line Pinks	22	1.6	19	7	0.6	6
Winston S-line green	21	1.9	17	7	0.7	6
Karelia S Green	23	2.1	21	3	0.3	2
Dunhill Blue Flow XL	21	1.7	22	7	0.6	9
West Orginal Red	26	1.8	26	10 - 11	0.7 - 0.8	10 - 11
Camel Activate White	20	1.5	22	6	0.5	7
Winston Blue	22	1.7	24	6 - 8	0.5 - 0.7	7 - 9
Benson & Hedges Gold	25	2.2	26	10	0.9	10
Winston Red	25	1.8	26	10	0.8	10
American Spirit Original Orange	24	2.2	25	3	0.3	3
Marlboro Mix	24	1.7	22	9	0.7	9
Chesterfield Orange L	25	1.7	25	10	0.7	10
Marlboro Beyond Green	20	1.3	22	8	0.6	10
Marlboro Gold	22	1.5	21	8	0.6	9
Pueblo Classic	24	2.4	25	10	1	10
Elixir Fresh	22	1.7	24	8	0.6	9
Elixir Plus	24	2.0	21	9	0.7	8
L&M Forward Green	20	1.1	22	8	0.6	10
Elixir Red	28	2.3	27	10	0.8	10
Black Devil Black	23	2.0	24	10	1	10
Pueblo Blue	23	2.2	26	6	0.7	6
L&M Blue	24	1.6	23	8	0.6	9
Marlboro Bright	25	2.0	24	10	0.8	10
Marlboro Red	28	1.9	26	10	0.7	10
Texas Red House Red	19	1.3	23	10	1	10
Texas Red House Blue	19	1.2	24	10	1	10
Riverside Red	23	1.8	26	10	1.0	10
Ruba Red	20	1.3	25	10	1	10
Titaan Blue	20	1.4	26	8	0.6	9
Mark Adams No1 org.gold	24	1.8	28	6	0.5	5
Ruba Blue	22	1.4	26	10	1	10
Boston White	21	1.5	26	10	1	10
Ruba White	20	1.3	24	10	1	10
Titaan Red	28	1.9	29	10	0.8	10
Boston Red	22	1.5	26	10	1	10
Riverside Blue	21	1.5	25	10	1	10

Published by

**National Institute for Public Health
and the Environment, RIVM**

P.O. Box 1 | 3720 BA Bilthoven
The Netherlands
www.rivm.nl/en

July 2023

Committed to health
and sustainability