JIMCO KPC

Device for reduction of grease and oil deposits in hoods and ducts and for reductions of the emission of particles and odour in ventilation air from commercial kitchen cooking hoods

Document	**Test Plan**
Date	November 2012
Document Responsible	Arne Oxbøl

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1. INTRODUCTION

This test plan is the implementation of a test design developed for verification of the performance of an environmental technology following the DANETV method. See the verification protocol /1/ for details on organization and implications.

1.1. VERIFICATION PROTOCOL REFERENCE

JIMCO KPC[1], DRAFT, version 5, November 2012.

This document is the test plan to be used for verification of a UV-C[2] technology used in hoods and ducts in ventilation air from commercial kitchen cooking hoods.

1.2. NAME AND CONTACT OF PROPOSER

JIMCO A/S
Ellehaven 4 A
DK-5900 Rudkøbing
Denmark
Contact: Jimmy K. Larsen
E-mail: jkl@jimco.dk
Phone: +45 6251 5456

1.3. NAME OF TEST BODY/TEST RESPONSIBLE

The Danish Center for Verification of Climate and Environmental Technologies (DANETV), FORCE Technology DANETV, Air and Energy Center

Verification Test Centre (DANETV)

FORCE Technology
Park Allé 345
DK - 2605 Brøndby
Denmark

Test responsible

Arne Oxbøl
E-mail: aox@force.dk
Phone: +45 4326 7130

2. TEST DESIGN

2.1. TEST SITE

The test will be conducted at a McDonald's restaurant in Denmark by FORCE Technology. The installation of JIMCO KPC is done by JIMCO, which also will provide the necessary documentation and operation instructions for the tests.

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[1] KPC: Kitchen Pollution Control

[2] UV-C: UV radiations in the C band

2.1.1. Types

On-site tests

2.1.2. Addresses

McDonald
Jyllingevej
2610 Rødovre

2.1.3. Descriptions

McDonald is a commercial kitchen based primarily on deep fry cooking and beef roasting on a griddle. On the test site is two deep fry cooking places and one griddle, each equipped with a hood. A central ventilator ventilates the cooking places through the hoods.

Each hood is equipped with Jimco KPC – a set of UV-lamps – immediately after a set of grease filters. Ducts lead from each cooking place to a common duct leading to the ventilator. The ducts from each cooking place are equipped with inspection hatches, by means of which inspection of deposits in the ducts can be done.

The ventilator exhaust is emitted from the roof.

2.2. TESTS

2.2.1. Test methods

Parameter	Unit	Method
Odour	OU/m³	Olfactometry
Oil mist	mg/m³	Collection on filters - weighing
Oil mist	mg/m³	Collection on filters – analysis of oil components
Inspection	-	Visual inspection of grease deposit Pictures
Inspection	Weight/area/time	Removal of deposit from duct wall - weighing

2.2.2. Test staff

Test responsible: Arne Oxbøl

Field responsible: Thue Grønhøj Frederiksen

2.2.3. Test schedule

The test is done by means of the following samples[3] – primarily at the production conditions: production with UV applied and production without UV applied.

[3] "Warm" background means the odour concentration in the ducts shortly after the kitchens closure, when the air from the kitchen is still warm and the system has not cooled down. "Cold" background

Pretest - week 45								
Sample	1	2	3	4	5	6	7	8
Treatment	Prod. + UV	Prod.	Prod. + UV	Prod.	"warm" background		"cold" background	
Odour	x	x	x	x	x	-	x	x
Ozone	x	-	x	-	-	-	-	-
Flow	-		-	-	-	-	-	-
Oil mist	-	-	-	-	-	-	-	-
Inspection	-	-	-	-	-	-	-	

Test - week 46 - day 1										
Sample	1	2	3	4	5	6	7	8	9	10
Treatment	Prod. + UV	Prod.	Prod. + UV	Prod.	Prod. + UV	Prod.	Prod. + UV	Prod.	"cold" background	
Odour	x	x	x	x	x	x	-	-	x	x
Ozone	x	-	x	-	x	-	-	-	-	-
Flow	x		x	-	x	-	-	-	x	-
Oil mist	x	x	x	x	x	x	x	x	-	-
Inspection	-	-	-	-	-	-	-	-	-	

Sampling is done as follows: Each treatment period has a duration of 15 minutes. Within this 15 minutes an odour sample is drawn and an oil mist filter is exposed. When changing from UV-treatment to no treatment the oil mist filter is changed as well. In the next UV-treatment period, the first oil mist filter is exposed again. After four periods with UV-treatment the oil mist filter is exposed for one hour.

Test - week 46 - day 2										
Sample	1	2	3	4	5	6	7	8	9	10
Treatment	Prod. + UV	Prod.	Prod. + UV	Prod.	Prod. + UV	Prod.	Prod. + UV	Prod.	"cold" background	
Odour	x	x	x	x	x	x	-	-	x	x
Ozone	x	-	x	-	x	-	-	-	-	-
Flow	x		x	-	x	-	-	-	x	-
Oil mist	x	x	x	x	x	x	x	x	-	-
Inspection	-	-	-	-	-	-	-	-	-	

Test - week 46 - day 3								
Sample	1	2	3	4	5	6	7	8
Treatment	Prod. + UV	Prod.	Prod. + UV	Prod.	Prod. + UV	Prod.	"cold" background	
Odour	x	x	x	x	x	x	x	x
Ozone	x	-	x	-	x	-	-	-
Flow	x		x	-	x	-	x	-
Oil mist	-	-	-	-	-	-	-	-
Inspection	-	-	-	-	-	-	x	

means the odour concentration the following morning, when the system has cooled down and before the kitchen starts cooking.

Test - week 47 - week 50								
Sample	1	2	3	4	5	6	7	8
Treatment	"cold" background		"cold" background		"cold" background		"cold" background	
Odour	x	x	x	x	x	x	x	x
Ozone	-	-	-	-	-	-	-	-
Flow	-	-	-	-	-	-	-	-
Oil mist	-	-	-	-	-	-	-	-
Inspection	x		x		x		x	

The follow up in week 47 - 50 is a weekly measurement of the background odour which presumably is a good indicator for the cleanliness of the ducts.

Final test - week 51						
Sample	1	2	3	4	7	8
Treatment	Prod. + UV	Prod.	Prod. + UV	Prod.	"cold" background	
Odour	x	x	x	x	x	x
Ozone	x	-	x	-	-	-
Flow	x		x	-	x	-
Oil mist	-	-	-	-	-	-
Inspection	-	-	-	-	x	

Test - effect of ozone - week 47						
Sample	1	2	3	4	5	6
Treatment	None	0,5 ppm ozone	1 ppm ozone	2 ppm ozone	3 ppm ozone	5 ppm ozone
Odour	x	x	x	x	x	x
Ozone	-	x	x	x	x	x

The test of ozone is a necessary test to show much odour is removed by a given amount of ozone. The UV-lamps generate ozone, and the ozone concentration is measurable at the time of sampling. In the time from sampling to analysis, the ozone disappears. If this is caused by reaction with odour molecules, the analysis result is not quite comparable to the concentration at sampling. It is, however, impossible to do the odour analysis immediately after sampling. The ozone test method is described in Appendix C.

The number of samples is summarized in paragraph 2.2.5. The schedule is summarized below.

Task	Week number 2012									
	42	43	44	45	46	47	48	49	50	51
Test plan	X									
Pre-test	X	X	X	X						
Test						X	X	X	X	
Effect of ozone						X				
Analysis				X	X	X	X	X	X	
Data handling and calculation				X	X	X	X	X	X	
Draft Test Report and QA										X
Final Test Report										X

2.2.4. Test equipment

Odour

Air is collected in sample bags made of nalophan by means of an evacuated box via a Teflon tube. The sample is analyzed by means of a dilution equipment – an olfactometer.

Oil mist

A partial gas stream is aspirated isokinetically through a planar filter (type: quartz micro fiber) and a drying column. The gas flow is aspirated by means of a pump unit consisting of a gas tight pump, a calibrated gas meter and a flow meter.

The filter is either weighed to determine the mass of particles (primarily oil mist) or analysed by gas chromatography using a sample of the grease as reference. Analysis by gas chromatograph is not accredited.

Additional equipment

Thermometer

Vane anemometer

Humidity meter

2.2.5. Type and number of samples

Odour

Week	45	46	47	48	49	50	51	Total
Odour	8	24	8	2	2	2	6	52
Ozone	2	9	6				2	19
Oil mist	-	4						4
Flow	3	9					3	15
Inspection	1	1	1	1	1	1	1	7

2.2.6. Operation conditions

The operation conditions are normal production of burgers, pommes frittes etc. on demand from the customers. The tests are preferably done at dinner time in the evening on maximum demand. Excepted from this is test of back ground odour (without production) which is done either immediately after closing time and/or shortly before opening time.

2.2.7. Operation measurements

The activity in the kitchen is recorded as turnover in the measurement periods – as detailed as possible.

Replacements of deep fry oil are recorded.

2.2.8. Product maintenance

Regular maintenance can preserve the operation ability and effectivity of the UV lamps. Recommended intervals are daily cleaning.

2.2.9. Health, safety and wastes

The use of the product does not imply special health, safety and waste issues in normal use. It must, however, be ensured that no one looks directly into the lamps, because UV radiation is harmful to the eyes.

The work during testing will be done according to the FORCE Safety Rules that are compliant with the extensive Danish rules for safe occupational health and the European regulations of work with chemicals.

3. ANALYSIS AND ANALYTICAL MEASUREMENTS

3.1. ANALYTICAL LABORATORY

Odour: FORCE Technology

Oil mist/particle weighing: FORCE Technology

Oil mist analysis: Technological Institute, Aarhus

3.2. ANALYTICAL AND MEASUREMENT PARAMETERS AND METHODS

See Appendix B

3.3. ANALYTICAL AND MEASUREMENT PERFORMANCE REQUIREMENTS

According to accreditation no. 51 and 65 from DANAK to FORCE Technology /2,3/.

3.4. PRESERVATION AND STORAGE OF SAMPLES

Odour samples are analyzed within 30 hours after sampling according to DS/EN 13.725 and not stored.

Oil mist/particle filters are transported to the laboratory immediately after sampling and analyzed without further storage.

3.5. DATA MANAGEMENT

Handling of data and calculation of results is performed according to the FORCE Technology DANAK accreditation no. 51 (also for parameters not covered by the accreditation).

Calculations will be performed by approved spread sheets and controlled spread sheet calculations.

3.6. DATA STORAGE, TRANSFER AND CONTROL

All reading data will be stored in handwritten form on paper and schemes.

All the data stored in data loggers will be transferred to the FORCE computer system, which is regularly backed up for data safety.

4. QUALITY ASSURANCE

All measuring, handling of data and calculation of results is performed according to the FORCE Technology DANAK accreditation no. 51 /2/ (also for parameters not covered by the accreditation).

All measuring data will be present in handwritten form.

Approved spread sheets for calculations of results has been subjected to an intensive control, to assure correct calculations, and consequently no further control is necessary.

4.1. TEST PLAN REVIEW

The test plan will be subject to internal review by the internal auditor from FORCE Technology:

Knud Christiansen
E-mail: knc@force.dk
Phone: + 45 7215 7886

4.2. PERFORMANCE CONTROL – ANALYSIS AND MEASUREMENTS

Not relevant.

4.3. TEST SYSTEM CONTROL

Not relevant.

4.4. DATA INTEGRITY CHECK PROCEDURES

All transfer of data from handwritten form to computer, will be subjected to 100 % control by another person.

New calculations in spread sheets will be subjected to 100 % check of all formulas and spot check of at least 20 % of all copies of the formulas.

4.5. TEST SYSTEM AUDITS

The internal auditor from FORCE Technology will make test system and performance audit according to the requirements described in the Centre Quality Manual /1/

4.6. TEST REPORT REVIEW

The test plan will be subject to internal review by the internal auditor from FORCE Technology:

Knud Christiansen
E-mail: knc@force.dk
Phone: + 45 7215 7886

5. TEST REPORT

The test report will follow the template of the Centre Quality Manual /1/ and will be included as an Appendix in the verification report.

5.1. AMENDMENT REPORT

The report section on amendments will compile all amendments from this test plan with justification of deviations and evaluation of any consequences for the test data quality.

5.2. DEVIATIONS REPORT

The report section on deviations will compile all deviations from this test plan with justification of deviations and evaluation of any consequences for the test data quality.

6. REFERENCES

/1/	ETV Test Centre and Test Organisation. Centre Quality Manual – Air and Energy Technology. FORCE Technology Document version 3. March 2012.
/2/	FORCE Technology DANAK accreditation no. 51. Accreditation to testing Environmental samples: Air, water, soil, waste. Etc
/3/	FORCE Technology DANAK accreditation no. 65. Accreditation to analyse Environmental samples: Air, water, soil, waste. Etc.

Appendix A

Terms and definition

Effect	The way the target is affected
ETV	Environmental technology verification (ETV) is an independent (third party) assessment of the performance of a technology or a product for a specified application, under defined conditions and adequate quality assurance.
Evaluation	Evaluation of test data for a technology product for performance and data quality
Matrix	The type of material that the product is intended for
Method	Generic document that provides rules, guidelines or characteristics for tests or analysis
Performance claim	The effects foreseen by the vendor on the target(s) in the matrix of intended use
Performance parameters	Parameters that can be documented quantitatively in tests and that provide the relevant information on the performance
QA	Quality assurance
Standard	Generic document established by consensus and approved by a recognized standardization body that provides rules, guidelines or characteristics for tests or analysis
Target	The property that is affected by the product
Test/testing	Determination of the performance of a product for parameters defined for the application
Verification	Evaluation of product performance parameters for a specified application under defined conditions and adequate quality assurance

Appendix B

Analytical methods

Gas temperature: The gas temperature is measured with a pt100-thermocouple or a NiCr/NiAl-thermocouple connected to a digital thermometer.

Range: -40 - 600 °C

Uncertainty: 4 °C (absolute)

FORCE Technology method: EM-03-01

Reference/standard: VDI 3511 bl. 1-5, IEC 584-2, IEC 584-2 amd. 1

Flow: The gas velocity is measured by means of a calibrated vane anemometer. The velocity is determined in a number of measuring points across the duct section. The flow is calculated based on the velocity and the section area.

Range: 0 - 30 m/s

Limit of detection: 1 m/s

Uncertainty: 10 % of measured value (95% confidence interval).

FORCE Technology method: EM-02-02

Reference/standard: ISO 10780

Oil mist: A gas stream is aspirated isokinetically through a filter. The filter is extracted with toluene and the extract is analysed by means of gaschromatography with flame ionization detector (FID). The analysis is calibrated to a sample of the oil in question (fry oil, meat fat). The method is not accreditated.

Uncertainty: 15 % of measured value (95% confidence interval).

FORCE Technology method: EM-51-01

Subcontractor: Teknologisk Institut, DANAK akk. nr. 380

Reference/standard: USEPA Method 0010

Alternative determination of oil mist – by weight. Sampling is done as above, the analysis is done by weighing.

Range: 0 - 25 mg/m³(n,t)

Limit of detection: 0,05 mg/m³(n,t)

Appendix B

Analytical methods

Uncertainty: 10 % of measured value (95% confidence interval).

FORCE Technology method: EM-01-02

Reference/standard: VDI 2066 bl.1

Odour concentration: Sampling of air/gas sample in a suitable sample bag of Tedlar or Nalophan is done by means of an evacuated box and Teflon tubing. Sampling of air with dew point <20°C is done directly to the sampling bag. Sampling of humid air (dew point >20°C) is done with sufficient dilution with nitrogen to prevent condensation of water. The amount of nitrogen is estimated based on knowledge about or measurement of the water concentration in the air. The precise degree of dilution is determined in the laboratory by measurement of either oxygen (FORCE Technology methods EM-06-01, EM-06-02 or EM-06-03) or/and carbon dioxide (FORCE Technology method EM-05-01). The samples are analyzed by means of olfactometry according to Danish EPA guideline 4/1985.

Range: 75 – 2.000.000 OU/m³(20°C,f)

Limit of detection: 75 OU/m³(20°C,f)

Uncertainty / Variation: A factor 1.8 to both sides of measured value (95% confidence interval).

FORCE Technology method: LU-01-01

Reference/standard: DS/EN 13.725

Inspection of oil deposit: Visual inspection, where the deposits are described in terms of amount (minor, significant, heavy), color, physical state (film, solid). The deposits are photographed.

Appendix C

In-house methods

Ozone test method

By means of an ozone generator (lamp) an air stream with app. 50 ppm ozone is formed. The air stream is mixed with a sample of untreated ventilation air from the kitchen.

One sample of untreated air (app. 100 liter) is divided in a number of smaller samples (app. 15 liter). The small samples are admixed with volumes of ozon rich air to obtain ozone contents corresponding to app. 0,5 ppm, 1, ppm, 2 ppm, 3 ppm and 5 ppm. After sufficient reaction time to remove all ozone the samples are analyzed by olfactometry together with an untreated sample.

The reduction of odour corresponds to maximum fault given by analyzing hours after sampling. The fault will not be corrected for but information will be part of the evaluation of the effect of Jimco KPC.