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Is SMART LDAR correctly applied today in Europe? Take a look at the differences between CWP and AWP LDAR.

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AGENDA

- **Introduction and references**
- **CWP LDAR main concepts**
- **AWP LDAR main concepts**
- **Netherlands guidelines NTA 8399**

Introduction and references

LDAR is a worldwide diffused 25 years old inspection routine based on EPA 453/R/95 rules and EPA 21 Method detection technique.
EPA Method 21 called CWP (Current Work Practice) was compared at the beginning of the century with the emerging technique IR OGI called AWP (Alternative Work Practice) in order to establish if they were equivalent.

The equivalence

At the end of 2008 EPA confirmed that these techniques can be considered equivalent BUT under specific restrictions:

1) it needs to be verified if the IR Camera CAN detect the stream of the area (unit) under survey;
2) since the camera is not able to detect small leakers we need to increase the inspection frequency;

Here in Europe the SMART LDAR restrictions are almost disappeared and often the AWP inspections are carried out with discretionary procedures. Just few European documents offer right guidelines about SMART LDAR and maybe the most complete is:

Netherlands Technical Agreement NTA 8399

References

Sources:

- EPA 453/R/95
- EPA 6560-50-P
- Netherlands Technical Agreement NTA 8399
- “Equivalent Leak Definitions for SMART LDAR when using optical gas imaging” (Epperson, Lev-on,Taback, Siegell, Ritter)
- “Monte Carlo Analysis to define Equivalent Leak Definitions for SMART LDAR when using optical gas imaging” (Epperson, Lev-on, Siegell, Ritter)
- “Methods for quantification of Mass Emissions from leaking process equipment when using optical gas imaging for leak detection” (Epperson, Lev-on, Taback, Siegell, Ritter, Gilmer)
- “Derivation of new emission factors for quantification of Mass Emissions when using optical gas imaging for detecting leaks” (Epperson, Lev-on, Siegell, Ritter)
- API Smart LDAR (Dave Fashimpaur – Paris 2006)

CWP LDAR Main Concepts

- **Leak Definition**
  - Is the ppm emission limit for which the equipment is considered Leak or No Leak (usually it can be 500 or 1,000 or 10,000 ppm)
- **Monitoring Frequency**
  - Is the time between two following monitoring (it can be yearly, half yearly, quarterly)
- **Fraction Leaking**
  - Is the ratio between the leakers and the inventory of equipment and it can be calculated globally or for each group of sources
- **Effectiveness**
  - Is the emission reduction goal and it can be reached thanks to the Leak Detection And Repair actions

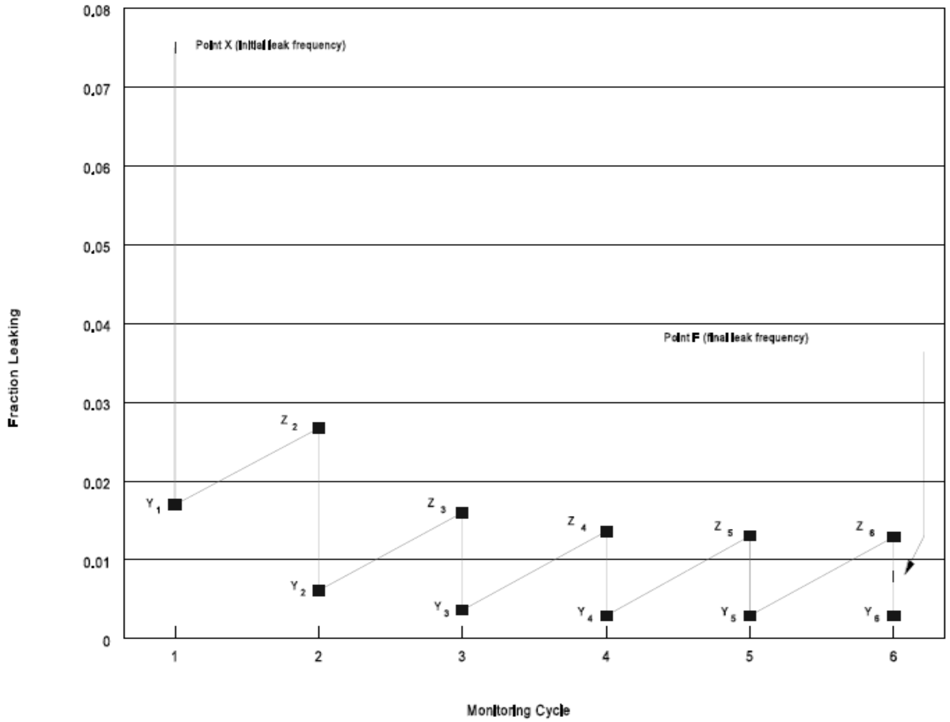
LDAR Fraction Leaking and Effectiveness

The control effectiveness is calculated as:

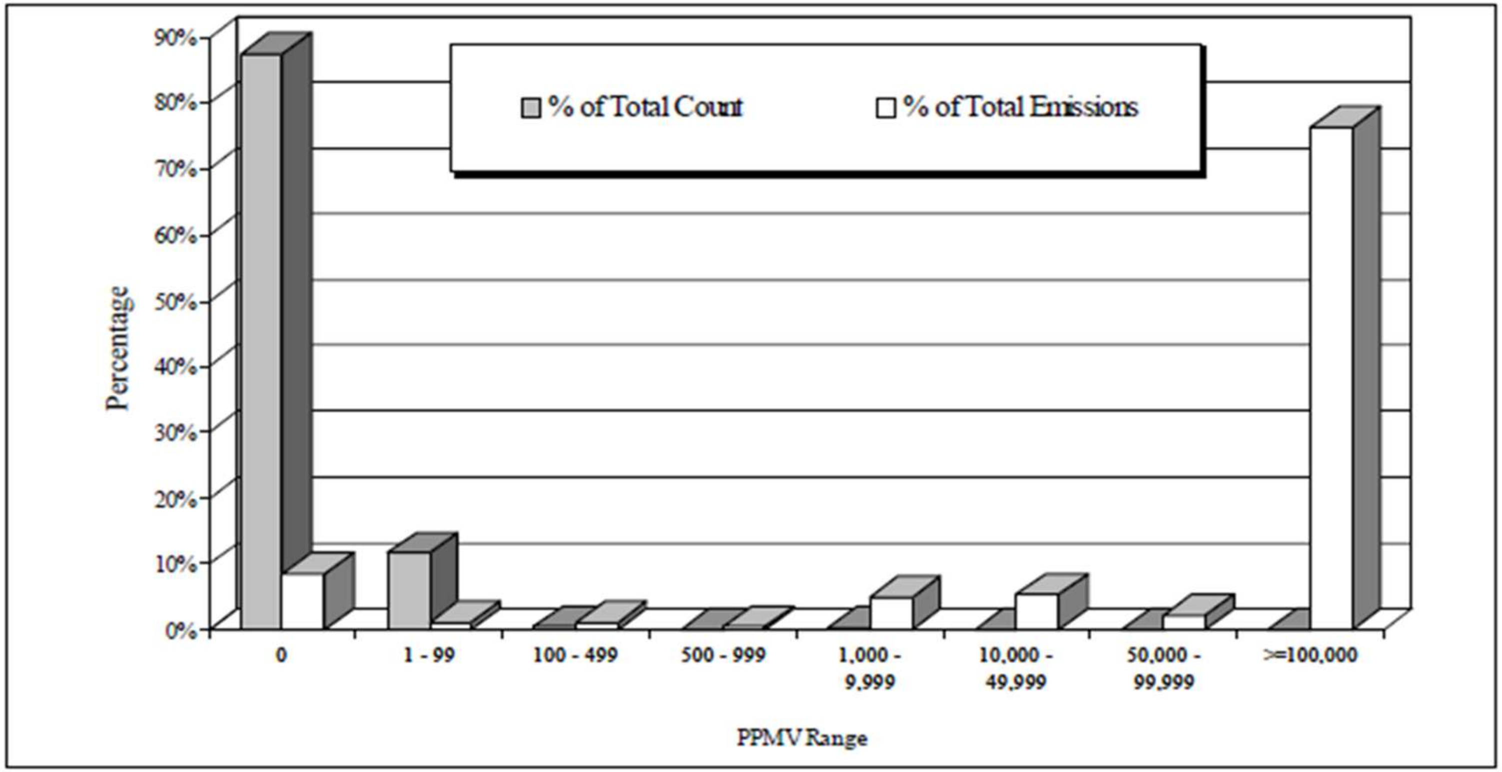
$$Eff = (ILR - FLR)/ILR \times 100$$

where:

- Eff = Control effectiveness (percent);
- ILR = Initial leak rate (kg/hr/source); and
- FLR = Final leak rate (kg/hr/source).



The distribution of the Leakers



AWP LDAR Main Concepts

«An alternative and more cost-effective approach for controlling these large leakers would entail more frequent monitoring of process equipment, focusing on the detection and repair of the highly leaking components that contribute the most to overall facility fugitive emissions. This approach has been called “Smart LDAR” and optical imaging instruments, which significantly reduce monitoring costs, are now becoming available to implement such an alternative work practice (AWP)»

from “Monte Carlo Analysis to define Equivalent Leak Definitions for SMART LDAR when using optical gas imaging” **(Epperson, Lev-on, Siegell, Ritter)**

MonteCarlo Simulations

The results showns in next Table 1 demonstrate that it is possible to find threshold emission rates that would need to be detected by optical imaging techniques, when they are used to identify leaking components as part of an alternative work practice. These threshold emission rates for valves, pumps and connectors are applicable for monitoring frequencies of 60, 45 or 30 days as compared to a work practice that is based on quarterly monitoring (i.e. every 90 days). Hence in order for an alternative valve work practice to acheive equivalent control effectiveness with current quarterly LDAR programs (with a 500 ppm leak definition) would require employing an optical imaging instrument with a detect sensitivity of 60, 85 or 100 gr/h for monitoring intervals of bi-monthly, semi-quarterly or monthly respectively.

from "Monte Carlo Analysis to define Equivalent Leak Definitions for SMART LDAR when using optical gas imaging" (Epperson, Lev-on, Siegell, Ritter)

MonteCarlo Simulations

Table 1. Equivalency Thresholds obtained by Monte Carlo Simulations for Individual Process Components

Current Monitoring Frequency	Component Type	Current Leak Definition (ppmv)	Equivalency Threshold (gr/hr) for Alternative Work Practices		
			Bi-Monthly (60 days)	Semi-Quarterly (45 days)	Monthly (30 days)
Quarterly	Valve	500	60	85	100
		1,000	61	85	110
		10,000	69	90	130
	Pump	500	180	210	280
		1,000	180	220	280
		10,000	210	280	430
	Connectors	500	24	33	44
		1,000	24	33	44
		10,000	28	44	60

Notes:
- Current work practice uses U.S. EPA Method 21 for monitoring
- Alternative work practices were simulated as using optical imaging systems for monitoring

EPA 6560-50-P 2008

<u>The equivalence between CWP and AWP is confirmed if the stream is detectable and the monitoring plan can allow the same effectiveness of the CWP plan.</u>

$$E_{dic} = (E_{sds}) \sum_{[k;i=1]} x_i$$

Where:

E_{dic} = Mass flow rate for daily instrument check, grams per hour

x_i = Mass fraction of detectable chemical (s) I seen by the optical gas imaging instrument, within the distance to be used in paragraph (i) (2) (iv) (B) of this section, at or below the standard detection sensitivity level E_{sds}

E_{sds} = Standard detection sensitivity level from table 1 to subpart A, grams per hour

k = Total number of detectable chemicals emitted from the leaking equipment and seen by the optical gas imaging instrument

EPA 6560-50-P 2008

Table 1 to subpart A to part 60 – Detection sensitivity levels (grams per hour)

Monitoring Frequency for Subpart	Detection Sensitivity Level
Bi-Monthly	60
Semi-Qarterly	85
Monthly	100

When this alternative work practice is used to identify leaking equipment, the owner or operator must choose one of the monitoring frequencies listed in this table in lieu of the monitoring frequency specified in the applicable subpart.

OGI - Sample 1

OGI - Sample 2

OGI - Sample 3

The IR Camera

The IR camera is a portable optical instrument that enables VOC emissions to be made visible in real time.
Basically such a camera consists of:

<u>a lens, a filter, a detector, an electronic part that process the detector signal, a display to make the signals visible</u>

The filter ensures that only a very narrow IR band is allowed to pass through to the detector. This wavelenght equals the wavelenght at which the gases to be detected absorb IR radiation. As the back ground radiation is absorbed by these gases, the gases can be made visible as a cloud.

from Netherlands Technical Agreement NTA 8399

The IR Camera

Wind Speed	0 mph		2 mph		5 mph	
	OGI A	OGI B	OGI A	OGI B	OGI A	OGI B
Compound	g/hr	g/hr	g/hr	g/hr	g/hr	g/hr
Benzene	34.72	>70.1 B	>66 B	>70.1 B	ND	>70.1 B
Ethylbenzene	20.6	7.6	48.9	53.2	ND	>75.9 B
Heptane	13.55	3	28.8	21	>51.4 B	48
Hexane	4.4	2.9	18.25	37.6	52.1	57.8
Isoprene	28.8	32.8	>51.4 B	59.6	ND	>59.6 B
Methanol	23.5	16.7	55.4	41.7	>153.9	69.3
MEK	32.15	5.3	61.1	60	ND	>70.5 B
MIBK	11.1	7.01	60.4	24.6	ND	70.1
Octane	11.1	4.36	31.7	18.7	ND	62.2
Pentane	DNT	13.8	DNT	25.4	DNT	45.8
1-Pentene	9.85	14	>25.2 B	30.9	ND	47.7
Toluene	34.3	22.6	>65.2 B	>75.3 B	ND	>75.3 B
Xylene	30.75	15.1	64.9	52.8	ND	>75.3 B

from API Smart LDAR, Dave Fashimpaur – Paris 2006

The IR Camera

Figure 1. Aromatic Compound IR Absorbance.

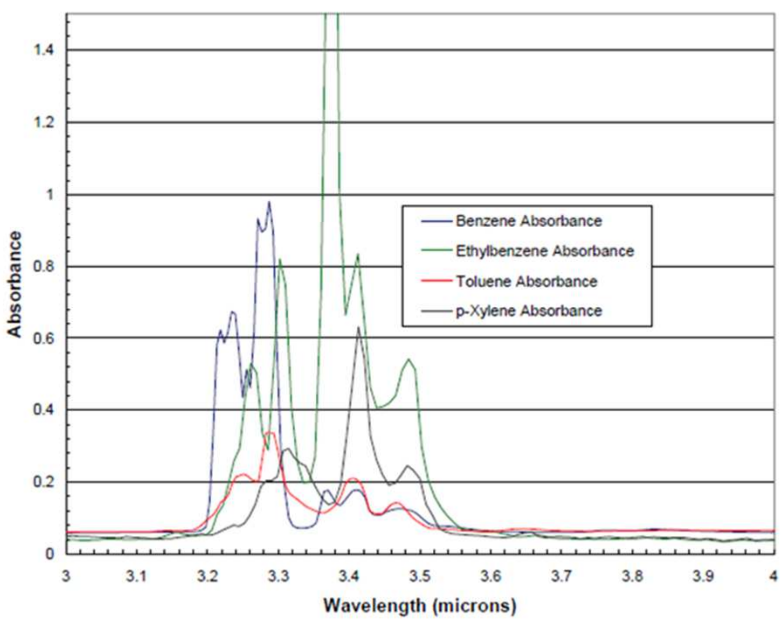
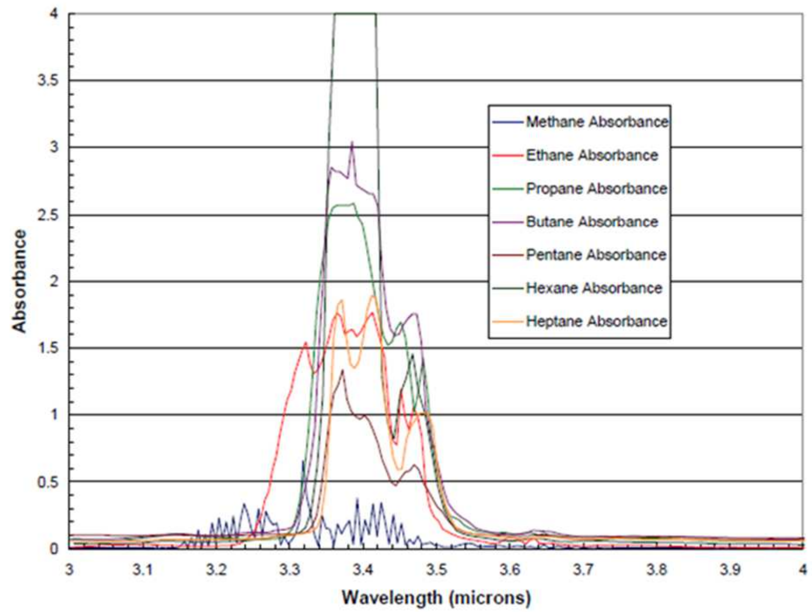


Figure 2. Alkane IR Absorbance.



from API Smart LDAR, Dave Fashimpaur – Paris 2006

Netherlands guidelines NTA8399

Netherlands technical agreement

NTA 8399

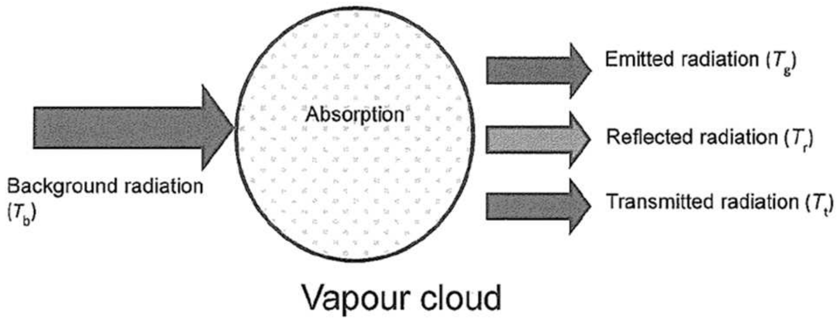
(en)

Air quality - Guidelines for detection of diffuse VOC emissions with optical gas imaging

Identifying the sources of emission

A VOC emission can be made visible if three conditions are met:

- the VOC emission shall absorb energy in wavelenght range that the filter allows to pass through
- there shall be a difference between the background radiation emitted and the total radiation emitted by VOC emission
- the VOC emission shall be moving



from Netherlands Technical Agreement NTA 8399

Identifying the sources of emission

- where the potential sources of emissions are located (background interference)
- how the sources of emission are distributed over the area (it could be hard identify exactly which is the leaker)
- the number of angles from which will be filmed (source(s) hardly accessible)
- how much time is needed in order to measure all potential sources of emission (it depends to the previous considerations)

from Netherlands Technical Agreement NTA 8399

Identifying the sources of emission

Various factors affect the measurement results. Decide in advance under what condition the measurements will or can be carried out.

Possible factors include:

- air temperature
- wind speed
- humidity
- cloud cover
- solar strenght

from Netherlands Technical Agreement NTA 8399

Identifying the sources of emission

A measuring protocol to be drawn up for LDAR measurements shall concretely specify the distance to the source to be observed and the number of angles from which a potential source will be filmed.

It is recommended no measurements shall be conducted under emitting sources that have been exposed to fog, precipitation and/or wind force 4 or higher (moderate one with wind speeds between 20 km/h and 28 km/h).
The visibility of a VOC emission strongly depends on weather: it can be blown away and diluted by wind. Laboratory research proves that the detection limit of methane increases from 2 g/h at wind speed of 7,2 km/h up to 11 g/h at a wind speed of 13,7 km/h.

from Netherlands Technical Agreement NTA 8399

Thank you !

Do you have questions?

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