The European Association of Internal
Combustion Engine Manufacturers

EUROMOT

EUROMOT POSITION

New LCP BREF and Future Aspects of the Industrial Emissions Directive 2010/75/EU

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Executive Summary

This paper provides recommendations of EUROMOT on certain aspects of the Best Available Techniques (BAT) conclusions and the BAT reference document for large combustion plants (LCP-BREF). [1,2]

In particular, EUROMOT recommends:

- using the maximum limit value of the BAT-AEL range given by the LCP BREF in the permitting procedure for zones where the environmental quality standard is fulfilled; and

- using the "dissenting/approved split views" in chapter 12 of the LCP BREF when working out future Annex V limits for liquid fired engines. This is needed in order to maintain a meaningful balance between costs and environmental benefits, i.e. the derogation possibility for special areas. This will also give industry a possibility to develop new/improved BAT technologies which are not commercially available on today's markets.

[1] COMMISSION IMPLEMENTING DECISION (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants
[2] Best Available Techniques (BAT) Reference Document for Large Combustion Plants, Final Draft (June 2016)

Furthermore, a brief overview is given on the emission derogation policies in emergency situations. Some text needs some further clarification in IED 2010/75/EU in order to avoid misinterpretations.

In order to harmonize emission limits in the EU, additional emission components to those present in LCP BREF for the affected prime mover technology should not imposed on national/regional levels. See also below item 1. In pricnciple, harmonized emission limits in the EU would facilitate the development of more cost-effective power plant solutions.

1. General Introduction

LCP (Large Combustion Plant) BREF (Best available techniques REFerence document) was published in the EU Official Journal on August 17th 2017 /1/. This was the final step of a process which started up already in year 2011. According to Article 21(3) of the IED (Industrial Emissions Directive) 2010/75/EU authorities shall **within 4 years** of the publication of the decisions implement the BREF into national legislation and apply it in permitting processes.

IED 2010/75/EU Articles 13(7),15(3) and 19 refer to the LCP BREF document in regard of BAT emission values to be followed. Article 15(3 a) of the IED clearly stipulates that a set emission limit value may not exceed the set BAT levels of the LCP BREF document.

Article 18 stipulates where required by an environmental quality standard, stricter conditions than those achievable by best available techniques additional measures shall be included in the permit without prejudice to other measures which may be taken to comply with environmental quality standards. Article 15(4) stipulates that the competent authority may in specific cases set less strict (than BAT) emission limit values (i.e. a derogation) if the environmental quality standard is fulfilled. The text of this Article continues as:
*"Such **a derogation may apply only** where an assessment shows that the achievement of emission levels associated with the best available techniques as described in BAT conclusions **would lead to disproportionately higher costs compared to the environmental benefits** due to:*

a) the geographical location or the local environmental conditions of the installation concerned; or
b) the technical characteristics of the installation concerned.

The competent authority shall document in an annex to the permit conditions the reasons for the application of the first subparagraph including the result of the assessment and the justification for the conditions imposed.
*The **emission limit values set** in accordance with the first subparagraph **shall, however, not exceed the emission limit values set out in the Annexes to this Directive**, where applicable. The competent authority shall in any case ensure that no significant pollution is caused and that a high level of protection of the environment as a whole is achieved."*

In Annex V of the IED 2010/75/EU emission limits related to combustion plants are included, amongst all for gas fired lean burn engines. That means, **Annex V contains the maximum emission limits (as lower emission values are not allowed) which a derogation can be based on.**

In order to make the implementation of the new LCP BREF document based on a cost effective and available technique BAT approach, EUROMOT has in this paper included some information from the LCP BREF writing (update) process and also some advice for the next steps i.e. the national implementation of the new LCP BREF and future update of the IED.

Amongst all following items are briefly described in below text:

- Background information about some set BAT emission span (thresholds);
- Recommendation why the maximum span value shall be used in the permitting process
- Recommendation why approved split views of chapter 12 of LCP BREF shall be included in the future IED Annex V when working out the emission "safety net" limits; and
- Emission compliance requirements in emergency situations.

This document is focusing only on new plants. According to the LCP BREF: a new plant is a combustion plant first permitted at the installation or a complete replacement of a combustion plant on the existing foundations following the publication of the LCP BREF.

2. BAT (Best Available Techniques) emission value in the permitting process

2.1. Liquid fired engines

Article 3.2 /1/ (expected to be included into chapter 10 of the final LCP BREF document) contains a time limited derogation for SIS/MIS (remote islands):
"*As regards HFO- and/or gas-oil-fired engines, secondary abatement techniques for NOx, SO2 and dust may not be applicable to engines in islands that are part of a small isolated system (1) or a micro isolated system (2), due to technical, economic and logistical/infrastructure constraints, pending their interconnection to the mainland electricity grid or access to a natural gas supply. The BAT-AELs for such engines shall therefore only apply in small isolated system and micro isolated system as from 1 January 2025 for new engines, and as from 1 January 2030 for existing engines*".[3]
Above derogation (although time limited) seems to be built on the Article 15(4) spirit of the IED.

2.1.1. NOx (Nitrogen Oxides) emission span level

In table 18 /1/ of the LCP BREF BAT AELs (Associated Emission Levels) for NOx given. In order to achieve the set NOx limits an efficient secondary abatement technique such as SCR is needed:
"*Selective reduction of nitrogen oxides with ammonia or urea in the presence of a catalyst … The degree of NOx removal depends on the catalyst used: at high NH_3 to NOx ratios, a* ***high NOx removal efficiency*** *can be obtained, but simultaneously the* ***amount of unused ammonia (NH_3 slip) in the clean flue-gas increases*** *considerably. The ammonia slip should be as low as possible, in order to avoid the risk of NH_3 reacting with SO3 in the flue-gas during cooling of the flue-gas, which can lead to fouling and corrosion of the heating surfaces by the ammonium bisulphates ($(NH_4) HSO_4$ or 'ABS') formed.*", see chapter 3.2.2.3.11 /2/. Further text in chapter

[3] See article 2 of Directive 2009/72/EC for more information about SIS/MIS

1.3 /1/ for BAT 7- associated emission levels of ammonia states, "*In the case of plants combusting biomass and operating at variable loads as well as in the case of engines combusting HFO and/or gas oil, the* ***higher end of the BAT-AEL range is 15 mg/Nm³*** ".
The EUROMOT Position paper /3/ attachment 1 C shows some NOx/NH_3 measurement results from the Maltese plant which was the main reference for the set NOx BAT span in LCP BREF. As can be seen from the attachment the **recommended ammonia higher limit value of 15 mg/Nm³ (15 % O_2) was frequently exceeded at low NOx levels.**

> **EUROMOT recommendation: The maximum span NOx value of table 18 shall preferable be used** as the permitting level in order to have an optimal balance for the overall plant emissions (to reach an optimal balance between NOx and NH_3 emissions).

2.1.2. Indicative CO and TVOC - **HFO (Heavy Fuel Oil) mode** emission span levels

Text below table 18 /1/ of the LCP BREF is stating **indicative** CO and TVOC emission spans.

2.1.2.1. CO

The gathered reference plant information in BATIS[4] showed that use of SCR led to increased CO emissions (page 7 /4/) from the plant. According to BAT 33 /1/ applicability of an oxidation catalysts is not recommended in context with fuels containing sulphur. Source /4/ also concluded that the BATIS (HFO plant) CO information was probable only high load operational values – at lower engine loads CO increases steeply.

> **EUROMOT recommendation:** If the *indicative* CO value for a HFO fired plant is used in the plant permitting process only the maximum value of the span should be used. The preferable approach should be to not use the indicative CO span at all and instead to use the practical BAT approach of LCP BREF 2006 chapter 6.5.5.5 and stipulate: "*For the minimisation of air emissions, good maintenance of the engine is regarded as BAT*".

2.1.2.2. TVOC

EUROMOT informed (page 8 /4/) that the set *indicative* TVOC span values for the HFO fired engine plant were too low based only on a few measurements. Used emission measurement method was not an EN based method with a differing measurement approach (different minimum sampling line temperature), measurements done probable only on high load conditions (TVOC increases steeply on lower loads) and the highest measured TVOC value of 74 mg/Nm³ was (simply claimed that Portuguese emission limit is lower which is NOT correct) disregarded by EIPPCB. Thus EUROMOT considers the **indicative TVOC span level to be too low and erroneous.** See also text about oxidation catalyst above.

> **EUROMOT recommendation:** The *indicative* (erroneous) TVOC span level shall not be used. If TVOC limit conditions are needed in the environmental permit process the BAT approach of LCP BREF 2006 chapter 6.5.5.5 is recommended: "*For the minimisation of air emissions, good maintenance of the engine is regarded as BAT* ".

2.1.3. SO_2 (Sulphur dioxide) emission span level

[4] European Commission – Joint Research Centre, Best Available Techniques Information System (BATIS, http://eippcb.jrc.ec.europa.eu/batis/

The SO_2 emission BAT AELVs span is largely set on the basis of the obtained measurement data from **only** (Maltese) engine plant with FGD in the BATIS. All other reference plants in BATIS were disregarded. It shall be noted that the HFO quality used in the Maltese plant equipped with a FGD (Flue gas Desulphurisation) unit was of a low sulphur brand maximum 0.7 wt-% S /6/. A lot of "faults"/operation disturbances occurred:
"*The plant, commissioned in 2012, has been dogged by a series of problems, which the Energy Ministry has blamed on the complexity of the engines and the abatement system that cleans exhaust before it is released into the air.*" /9/.

This Maltese reference is today converted to a plant operating on natural gas (as already mentioned as ongoing a few years ago on page 2 in /6/).
A normal HFO has a sulphur content of 1 .. 5 wt-% depending on the source. If a 3 % wt-% S HFO is used a SO_2 reduction efficiency of minimum about 94 % should be required in order **to fulfil the upper limit value of the set span.** For lower limit values a higher reduction efficiency should be required. If a dry FGD technology (as in the Maltese case) should be the chose a high reagent over stoichiometry is needed with a huge end product amount (containg a lot of unreacted reagent) as the result.
In order to optimize the overall environmental performance: minimize end product (waste) generation (which needs to be disposed in an environmentally acceptable way), minimize reagent and water (needed if a wet FGD is the choice) usage the upper span limit value is recommended. A lower SO_2-limit value should disable usage of some FGD technologies (dry methods) especially in context with higher sulphur heavy fuel oil brands.

> **EUROMOT recommendation:** The set SO_2 limit shall be such that as a minimum a light fuel oil (LFO) with a maximum 0.1 wt-% S can be used without FGD if commercially available for a plant. Set SO_2 limit shall not be such low set that some FGD technique options are unfeasible. The maximum span SO_2 value of table 19/1/ to be used in the permitting process in order to have an overall optimized environmental approach (according to the IPPC (Integrated Pollution Prevention and Control)) spirit) of the plant in cases where FGD is part of the plant design.

2.1.4. Dust emission span level

The dust emission BAT AELVs span (table 20 /1/) is set on the basis of the obtained measurement data from the **only** (Maltese) engine plant with dry FGD (with bag filters) in the BATIS. Bag filters are not a viable technique in most engine power plants due to the high flue gas temperature (250 .. 400°C depending on engine type /11/) and thus cooling is needed otherwise the material of the commercial available bag filters will be destroyed; in the Maltese plant flue gas was 170°C (page 14 /11/), flue gas to be below 170 .. 180°C in order to protect the filter material (page 9 /10/).
Thus EUROMOT has thus continously during the whole LCP BREF process without success stated that the set BAT AELVs for dust is beyond BAT, some more details below.
The measurement data in the Maltese reference plant indicated that the set dust liit should be set higher than 20 mg/Nm3 (15 % O2) to fulfil the 95th percentile of the plant operation profile, the plant also had big operational challenges /3/. Thus set BAT span in the LCP BREF is too low and in EUROMOT view the minimum level representing the BAT today is 30 mg/Nm3 (15 % O2) /3/.

The other secondary particulate abatement technique besides the bag filter is an ESP (Electro Static Precipitator) for a big liquid fired engine plant. The dry ESP is today not ready developed for fulfilling the set dust BAT AELVs span /3/.
Diesel particulate filters (DPFs) are not developed for engine units > 5 MWth (about 2 MWe) (page 258 /7/), In context with DPFs ULSD (Ultralow Sulfur Diesel) with max. 0.001 .. 0.0015 wt-% S is a prerequisite /12/.
Operating a low sulfur (maximum 0.1 wt-% s) and low ash diesel oil will still create higher dust emissions than the set BAT span maximum value. Operation on ULSD **on high loads** might be enough to fulfil the higher dust span limit (lube oil contributes besides the burned fuel to the dust emission). Note ! In previous LCP BREF anno 2006 the dust BAT AELV was for high engine loads > 85 % MCR, in the new LCPP BREF there is no such threshold limitation set. Particulate emission increases at part loads.

> **EUROMOT recommendation:** The **maximum span dust value of table 20 shall preferable be used** as the permitting level. As stated above ULSD usage might be enough for fulfilling the upper span range dust value at higher engine loads.

2.2. Gas fired engines (lean burn type)

2.2.1. NOx (Nitrogen Oxides) emission span level

In table 25 /1/ the NOx BAT AELVs is given in the LCP BREF. In order to meet the set NOx emission span set a secondary technique namely a SCR is needed. A SCR need a reagent urea or ammonia in order to enable the NOx reduction reactions. Note that the set BAT AELVs do not apply to the GD engine type.

> **EUROMOT recommendation:** The maximum span NOx value of table 25 should preferable be used in the permitting process in order to have an overall optimized environmental approach (according to the IPPC (Integrated Pollution Prevention and Control) spirit – production and transportation of the needed reagent to plant site create additional NOx and CO_2 emissions).

2.2.2. Indicative CO emission span level

Indicative CO BAT AELVs span is given in text below table 25. In order to fulfil the set span limits a secondary abatement techniques such as an oxidation catalyst is needed.

> **EUROMOT recommendation:** If the indicative CO value for a gas fired plant is used, the upper span value should be used, by this the oxidation catalyst size can be optimized (and avoid too frequent changes).

2.2.3. SG lean burn type engine HC (Hydrocarbon emission span level)

2.2.3.1. Formaldehyde

In table 26 /1/ is the formaldehyde BAT AELVs span given. In order to fulfil the set limits a secondary abatement technique such as an oxidation catalyst is needed. The lower span limit range would lead to frequent changes of the oxidation catalyst (a very efficient catalyst required), thus the higher range limit is preferred in order to have reasonable operational costs

in the long run. The oxidation catalyst is prone to poisoning/deactivation of sulfur, etc. which might be present in the natural gas. The changed operational profile of the thermal power plants in EU in recent yeas– more start and stops due to increased intermittent renewable electricity generation ratio in the grid – is likely to have a degradable impact on the catalyst performance /8/. In light of the ongoing H-gas standardization in EU /13/ (the approved EN 16726 : 2015 standard allows very high maximum sulfur limits (same level as in the EUROMOT paper)) which might lead to amongst all higher sulfur contents in the future in the natural gas the upper span value is recommended.

> **EUROMOT recommendation:** The maximum span formaldehyde value of table 26 should preferable be used in permitting in order to avoid frequent catalyst changes.

2.2.3.2. Methane (CH_4)

In table 26 is the CH_4 BAT AELVs span given. Note this limit value is given **at full engine** load and **calculated as "C"** (carbon). EUROMOT highlighted in the LCP process that the set lower span limit is too low, according to BATIS it **is based on a single sample (not an average as stated in LCP BREF) and thus unreliable /8/.** There are no commercial available oxidation catalysts on the market today for short chained alkenes such as CH_4 (chapter 11, section 11.6.1.2 /2/).

> **EUROMOT recommendation:** Only the maximum span CH_4 value of table 26 should be used in permitting process – no commercially available secondary abatement techniques exist today for the methane slip.

3. Derogation emission value in specific cases

Quotes from the IED 2010/75/EU:

- Article 30(9) stipulates: "*For the following combustion plants, on the basis of the best available techniques, the Commission shall review the need to establish Union-wide emission limit values and to amend the emission limit values set out in Annex V: a) the combustion plants referred in paragraph 8…* ".

Amongst all the diesel engine is referred to in paragraph 8.

- Article 41 stipulates: *Implementing rules shall be established concerning: a) the determination of the start-up and shut-down periods* .."

This task was finalized in May 2012 /14/. Thus it is expected that IED 2010/75/EU will be revised in the near future.
According to IED Article 15(4) competent authority may set less strict emission limit values than LCP BREF prescribes in *specific cases* (see above chapter 1 and below for more details). Article states further on:
"*The emission limit values set in accordance with the first subparagraph shall, however, not exceed the emission limit values set out in the Annexes to this Directive, where applicable* ."

In Annex V of the IED is currently only CO and NOx limits for the **lean burn gas fired engine** included, these are **similar to the maximum span values found in the LCP BREF 2006.** The liquid fired engine has currently no emission limits set in Annex V (see also Article 30 (8)). Annex V emission values are "safety net" limits which cannot in any case be exceeded when granting an environmental license to a plant. In above text has been shown that some of the BAT emission span values of the recent approved LCP BREF are very demanding and not technical viable today such as the particulate limit for new liquid fired engines.

In order to maintain the intention/meaning with the IED derogation Article 15 (4),
"*Such a derogation may apply only where an assessment shows that the achievement of emission levels associated with the best available techniques as described in BAT conclusions would lead to* ***disproportionately higher costs compared to the environmental benefits due to: (a) the geographical location or the local environmental conditions of the installation concerned…*****"**

The approved split views included in chapter 12 of LCP BREF should be utilized. *"Dissenting views expressed"* or *"approved split views"* of chapter 12 (result after a long dedicated work by the TWG members) is a new feature (missing in the previous LCP BREF 2006) and should be used for this purpose.
By this approach industry should get more time to develop the abatement techniques and the environmental cost impact and versus benefit be taken into account, old "maximum span "value" approach should disable the derogation possibility for specific cases and make it meaningless. I.e. for liquid fired engines split view contents should be utilized when working out the future Annex V chapter:

- No 60: BAT 35 – dust (table 20 /1/):
  - Increase higher ends of yearly (to 20 mg/Nm^3) and daily (to 30 mg/Nm^3) BAT AEL for new plants in general
  - Increase higher ends of yearly (to 35 mg/Nm^3) and daily (to 45 mg/Nm^3) BAT AEL for new plants in remote SIS/MIS islands

- No 54: BAT 32 /1/ - SCR applicability:
  Add applicability restriction: "Possible economic restrictions and/or lack of proper industrial infrastructure for the supply and/or the use of reagent in remote areas such as islands

- No 55. BAT 32 – NOx (table 18 /1/):
  - Increase higher ends of the yearly (to 240 mg/Nm^3) and daily (to 300 mg/Nm^3) NOx BAT-AEL ranges for new plants equipped with SCR and located on remote islands
  - Apply also footnotes /1/ 1 and 2 to new plants that cannot be fitted with secondary abatement techniques for techno-economic reasons

- NO 59: BAT 34: - SO_2 (table 19 /1/):
  Modify footnote 3 applying to new and existing plants as follows: The higher end of the yearly SO_2 BAT AEL range is 280 mg/Nm^3 and the higher end of the daily SO_2 BAT AEL range is 300 mg/Nm^3 if no secondary abatement technique can be applied,

4. Emergency cases

Combustion engine secondary abatement systems such as SCR take time to reach the temperature required to be effective and often require sustained periods of operation at significant load to maintain performance and operational safety. Additionally, the reagent used for many NOx secondary abatement systems has a limited storage life.
To maintain reliability, the engines used in these emergency applications should not be overly complex and should avoid the unnecessary cost of secondary abatement techniques that, based on the low running hours, would not be cost effective to the society.
In LCP BREF and IED 2010/75/EU a technique and cost-effective approach towards emergency can be seen:

- LCP BREF /1/ preface page L 212/10 states:
  "*The BAT-AELs set out in these BAT conclusions may not apply to liquid-fuel-fired and gas-fired turbines and engines for emergency use operated less than 500 h/yr, when such emergency use is not compatible with meeting the BAT-AELs*. "

- IED 2010/75/EU, preface (32):
  "*In the case of a* ***sudden interruption in the supply of low-sulphur fuel or gas resulting from a serious shortage, the competent authority should be able to grant temporary derogations to allow emissions of the combustion plants concerned to exceed the emission limit values*** *set out in this Directive*. "

- Article 30 (6):
  "5. *The competent authority may grant a* ***derogation f****or a maximum of 6 months from the obligation to comply with the emission limit values provided for in paragraphs 2 and 3 for sulphur dioxide in respect of a combustion plant which to this end normally uses low-sulphur fuel, in cases where the operator is unable to comply with those limit values* ***because of an interruption in the supply of low-sulphur fuel resulting from a serious shortage ….***
  6. The competent authority may grant a ***derogation from the*** *obligation to comply with the emission limit values provided for in paragraphs 2 and 3 in cases* ***where a combustion plant using only gaseous fuel has to resort exceptionally*** *to* ***the use of other fuels*** *because of a* ***sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility****. The period for which such a derogation is* ***granted shall not exceed 10 days except where there is an overriding need to maintain energy supplies "***

Article 30 (6) text is not clear enough and might lead to misinterpretations. A text clarification similar to as in the UNECE Gothenburgh Protocol (sub note "d)" below table 4 of Annex V /15/):

> "*A Party may* ***derogate f****rom the obligation to comply with the emission limit values for combustion* ***plants using gaseous fuel*** *which have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility. The exception time period shall not exceed 10 days except where there it is an overriding need to maintain energy supplies.*"

5. Conclusions

EUROMOT has in this document discussed issues related to the implementation of the recent approved LCP BREF. Recommendations are given on the following issues:

- In the permitting process the maximum emission span value should be applied in order to maintain an effective balance between environmental and cost aspects;

- In order to maintain a meaningful derogation possibility for special cases also in the future, approved split views (worked out by TWG experts) in chapter 12 of the LCP BREF should be included into Annex V of IED 201/75/EU; and

- IED and LCP BREF has a cost effective approach regarding emissions in emergency cases. IED text needs some minor change in order to make this clearer.

For more information please contact:

European Association of Internal Combustion Engine Manufacturers – EUROMOT aisbl
Dr Peter Scherm – General Manager
Phone: +32 (0) 28932141, peter.scherm@euromot.eu

6. References

/1/ EU OJ (August 17th 2017) at link: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2017:212:FULL&from=EN

/2/ LCP BREF Final Draft June 2016 at link http://eippcb.jrc.ec.europa.eu/reference/BREF/LCP_FinalDraft_06_2016.pdf

/3/ EUROMOT Position "LCP BREF Position for remote areas", April 2017 at http://www.euromot.eu/download/58eb382469b0961f65318b84

/4/ EU LCP BREF – Feedback on Liquid Fuel Engines; May 2015 at link http://www.euromot.eu/download/569feccc44870c9d77a05ff5

/5/ LCP BREF 2006 at http://eippcb.jrc.ec.europa.eu/reference/BREF/lcp_bref_0706.pdf

/6/ EUROMOT Position "Comments on Maltese Plant Data submitted to EEB (European Environmental Bureau) on December 2014", January 2015 at link http://www.euromot.eu/download/54da4c2cb49b86c3cbe73ca9

/7/ UNECE "Guidance document on control technologies for emissions sulpur, NOx, volative organic compounds and particulate matter ..", January 2015 at link http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/ECE.EB.AIR.117_AV.pdf

/8/ EUROMOT Position "LCP BREF EUROMOT Feedback on gaseous Fuelled Engines"; May 2015 at link http://www.euromot.eu/download/569feda84487f5bf8242a7d5

/9/ Times of Malta article at https://www.timesofmalta.com/articles/view/20131120/local/Faults-are-still-dogging-power-station-engines.495446

/10/ EUROMOT Position Paper "EUROMOT Response to CEFIC comments as of July 2014"; November 2014 at link: http://www.euromot.eu/download/5478c1c83efeb631842bcb77

/11/ EUROMOT Position "Draft 1 Large Combustion Plants BREF – BAT AELs for HFO-fired Engines"; September 2013 at link http://www.euromot.eu/download/54383683de278fdcb4d093b1

/12/ EUROMOT Position "Comments regarding the review of smaller combustion plants carried out under the Industrial emissions Directive"; January 2013 at link: http://www.euromot.eu/download/54383700de278fdcb4d0940c

/13/ EUROMOT Position "Gas Quality sulphur levels in natural gas"; April 2012, link http://www.euromot.eu/download/5438372ede278fdcb4d09478

/14/ "Commission Implementation Decision concerning start-up and shut-down periods for the purposes of Directive 2010/75/EU .."; May 2012, link http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012D0249&from=EN

/15/ UNECE Gothenburgh Protocol 2012 update at link http://www.unece.org/fileadmin/DAM/env/documents/2013/air/eb/ECE.EB.AIR.114_ENG.pdf

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