Key decisions document

Background explaining the decisions taken in developing a Quality Protocol for the production of processed fuel oil from waste lubricating oil

1. Introduction

The Court of Appeal judgement in *OSS Group Ltd v Environment Agency* considered the question '..whether a lubricating oil, thus not originally used as a fuel, which becomes waste can thereafter be burnt other than as waste…'. The court ruled that, in order for a waste to cease to be waste 'it should be enough that the holder has converted the waste material into a distinct, marketable product, which can be used in exactly the same way as an ordinary fuel, and with no worse environmental effects'. The Court suggested Defra and the Environment Agency should provide practical guidance for those affected on what it referred to as "the end of waste test".

The main criteria for 'end of waste' test was:

- the product is distinct from the input waste stream(s) thus involving a degree of processing
- the product is marketable, ie, there is certainty of use in the relevant market
- the product can be used in the same way as an ordinary fuel
- the product does not lead to adverse environmental effects, when compared with the effects of the virgin fuel it replaces.

To provide guidance to producers and users of processed waste oil, we have developed a Quality Protocol, compliance with which will mean that the processed material is no longer 'waste'. The Quality Protocol is analogous to those developed under the Department for Environment Food and Rural Affairs (Defra) funded Waste Protocols Project[1].

This Key Decisions paper describes the methodology used to develop the Quality Protocol. The main supporting documents are the notes of the meetings of the Technical Advisory Group and reports by ERM and EMRC. Detailed supporting information is provided in these reports, however, a summary of these documents is provided below.

2. Methodology

We undertook a number of steps to develop this Quality Protocol. In some instances, it was not possible to use an identical approach to that applied by the Waste Protocols Project. The steps taken are discussed below.

2.1 Setting up of an Advisory Group

In September 2007 a Waste Oil Technical Advisory Group (TAG) was established to ensure that we heard the views of a broad and representative cross section of stakeholders and to develop contact with holders of key information. Membership of the TAG is detailed in the report by ERM and included representatives from industry (UK and Europe), Government Departments, the Environment Agency and Energy Institute. The purpose of the TAG was to provide authoritative information to assist us with the development of our guidance.

Specifically, the aim of the TAG was:

[1] This joint Environment Agency and WRAP (the Waste & Resources Action Programme) initiative has developed a methodology which is being used to develop a series of Quality Protocols for specific non-fuel waste streams. The process involves working in consultation with industry and other regulatory stakeholders to enable recovery of raw materials from waste for productive use.

"To produce a technical report, recognised by (and produced with the support of) industry. The technical report will contain sufficient information to determine when waste lubricating oil has been reprocessed to such a level that it can be considered to be fully recovered for use as a fuel and no longer subject to the requirements of the regulatory waste regime."

The TAG met three times between August and November 2007. The outputs of the TAG activities and submissions were summarised by ERM as an independent consultant and agreed by the TAG in March 2008.

Minutes of the TAG meetings and outputs are available on: http://www.environment-agency.gov.uk/business/444304/1765106/1765136/1782311/1862147/1862167/

2.2 Report by the Independent Consultant (ERM)

Following a competitive tendering process, Environmental Resource Management (ERM) was appointed as an independent consultant to produce the TAG's Technical Report. This was to be based on information and data provided by the TAG and to use independent knowledge where appropriate. The Report was to be used to inform a Quality Protocol, which will set out the precise circumstances in which waste oil ceases to be considered to be a waste.

Based on the outcome of the TAG process ERM produced a technical report in which it also drew its own expert conclusions and made a number of recommendations, including the recommendation that further work to be undertaken to appraise the environmental burdens associated with the burning of waste oil and an assessment of alternative waste management routes. Some of ERM's conclusions and recommendations are summarised below (for full details see the main report):

- There were diverging views amongst the TAG members. These were apparent in relation to many aspects of the work – both in relation to specific aspects (eg, composition data for oils) and in relation to aspects of the approach undertaken by the TAG.
- TAG members pointed out that both virgin oils and waste derived oils contain components which may result in environmental impacts when burnt as a fuel and that both types of oils have been shown to fail limits set under the Waste Incineration Directive (WID) when burnt as a fuel.
- TAG agreed to focus on the composition of Class D and G oils (as defined within British Standard BS2869) and to compare these oil types to recovered oils. The intention was to consider what material limits would be appropriate if processed waste oils were to substitute virgin fuel oils.
- Data submitted by TAG members showed wide variations in the levels of substances in virgin and fuel oils. However, there was no consensus on whether the data was robust. Most believe the data was not sufficiently robust.
- GEIR (Association of Re-refining Industry in Europe - Groupement Europeen de IIndustrie de la Regeneration) stated that despite the TAG's focus on production of fuels, the requirements of converting waste oil into a distinct marketable product could be achieved through modern re-refining techniques – which represent the most environmentally-sound option.
- The focus of the discussions was on the environmental and human health impacts of chlorine, zinc, lead, chromium, copper, nickel and vanadium. However, the TAG was generally unable to draw any conclusions on the risks of these substances being present in waste oils.
- In order to ensure that the '*recovered product will not result in greater harm to human health and the environment than use of virgin product*', a detailed

comparison of the environmental and human health impacts that arise as a result of the consumption and burning of virgin fuel oils with those of the recovery and burning of waste oil should be undertaken.

We are grateful for the assistance of the National Symbiosis Programme which funded the development of the TAG report.

2.3 EMRC Report

We recognised that the data submitted by TAG members showed wide variations in the levels of chloride and heavy metals and that there had been no consensus on whether the data was robust. Section 3.3.1 sets out our approach to resolving this issue.

The TAG were in agreement regarding limits for nickel, chromium and vanadium. No assessment was provided by the TAG on the risk of zinc, lead and copper, which are present in significant quantities in waste oil.

To address this, we contracted Ecometrics Research and Consultancy (EMRC) to undertake an analysis of the environmental and health impacts of potential emissions of copper, lead and zinc associated with burning waste oil.

Assessment of the potential for emissions to cause harm to human health requires that they be tracked through various environmental media (air, water, soil, vegetation). Exposure through consumption of food, water and inhalation can then be quantified. EMRC performed this analysis by using the RiskPoll model developed by Dr J Spadaro and Prof. A Rabl. As there were considerable uncertainties around the amounts of copper, zinc and lead content in waste lubricating oils, a worst case scenario approach was adopted in the modelling work which used the highest levels of these metals reported in the ERM report. Also, as a worst case, it was assumed that all the metals present in the fuel oil product are released to the environment (ie, no abatement is available).

A summary of EMRC's conclusions and recommendations is given below. Further details are provided in the main report.

- Zinc, copper and lead are all capable of causing harm to human health but zinc and copper are also essential nutrients, so the body can tolerate them to a significant degree. This does not apply to lead which has no known beneficial effects.
- Incremental emissions of zinc, copper and lead from the burning of waste oils in the UK would make only a small contribution to exposures relative to available limit values. This is despite a number of worst case assumptions being applied in the analysis. However, if there are parts of the country with existing high levels of exposure to the metals it may be necessary to undertake some site-specific modelling before authorising the use of fuels containing elevated quantities of zinc, copper or lead.
- From the perspective that any increase in emission should be discouraged it may be logical to define two sets of limit values. The use of oil that met the lower limit could be relatively unrestricted, whilst oils that only met the upper limit could be restricted for burning in facilities with effective emission control systems.
- Another issue concerns the origin of the metals, and whether product controls should be applied before the metal contamination arises.

2.4 Development of Test Methods

In response to concerns about the suitability of existing test methods for determining the ash content of waste oil based fuels, the Energy Institute's Test Method Standardization Committee kindly agreed to help in developing a new standard for this. The scope of the test method covers all waste mineral oils but excludes waste vegetable oils. The title for the test method is *Determination of sulfated ash for burner oil derived from waste* oils. The test method is in its final stage of development.

3. Basis of Processed Fuel Oil Specifications

The broad criteria set by the Court for an end of waste test is discussed in Section 1 above. The main elements that affect the specification of processed waste oil are:

- Waste is converted to a distinct product ie, it is distinct from the input waste streams
- The product has gone through a conversion process to achieve this distinction, eg, contaminants that are significantly over and above those present in an ordinary fuel have been removed
- The environmental impact from the burning of the product is no worse than an ordinary fuel, ie, overall environmental burden of releases is similar.

The above elements were taken into account in setting the specifications within the Quality Protocol.

3.1 Choice of Fuel Oil Equivalent

The TAG proposed, and we support, the development of two standards; a gas-oil substitute equivalent to BS2869 Class D fuels and a heavy fuel oil substitute based on BS2869 Class G fuels.

BS 2869:2006 is the British Standard which controls the composition of virgin fuel oils for agricultural, domestic and industrial engines and boilers. Further details of this standard and specifications for Class D and Class G oils are discussed in section 4.2 of the ERM report.

The gas oil equivalent standard is only likely to be reached through some form of re-refining or distillation process. The heavy fuel oil equivalent will require processing of waste lube oils but not necessarily full re-refining or distillation.

The rationale behind having two standards is that there are already a number of classes of virgin fuel oils burned in the UK, and these two classes are commonly recognised and used by industry. In addition, it would not be appropriate to impose either the highest or lowest standards for these to all recovered oils. In future it may be that a processor can produce processed oil which complies with other categories in the above standard (eg, heating oil) and meet the end of waste test.

3.2 Processed waste oil constituents of interest

Constituents of processed oil that could affect the environment and human health were debated at length by the TAG. The majority view was that consideration should be given to setting specifications for the contaminants given in the table below. This is essentially

the same list as appears in the Waste Incineration Directive except zinc which is included because of its aquatic ecotoxicity and its significant presence in waste oils. In addition, lead, arsenic, cadmium, mercury and nickel are also subject to Air Quality objectives

The TAG did not reach a consensus on the limits for various contaminants in the HFO equivalent. However, a number of proposals were made by TAG members (see Table 6.1 of ERM Report for details) and these are summarised below. Note that the proposed ranges in the table refer to processed oil which is equivalent to HFO.

TAG member proposals: HFO equivalent product

Parameter	Proposed Limit (HFO equivalent)
Sulfur content [% (m/m)] (max)	0.65 -1.0
Total halogens , as chlorine (ppm)	100-1000
PCBs (ppm)	<5
Metals (ppm)	
Lead	25
Mercury	1
Nickel	5- 20
Chromium	4-5
Copper	40
Zinc	300
Arsenic	1
Cadmium	2
Thallium	1
Antimony	1
Cobalt	1
Manganese	5
Vanadium	5 - 20

3.3 Proposed concentrations of constituents of interest

3.3.1 Chloride and fluoride

For Class D (Gas oil) equivalent fuels the TAG agreed that no chloride or fluoride should be present. Accordingly, we propose a total halogen limit of 5 ppm for a Gas-oil equivalent fuel.

UK and European oil industry representatives on the TAG were adamant that ex-refinery heavy fuel oil would not contain any chlorides because the chloride is specifically removed before the main refining steps. However, some TAG members believed that virgin fuels could be contaminated with chloride from their movements by sea. If we assume that up to 1% sea water is present in the oil moved by sea, we could expect up to 158 ppm of chloride in this. No evidence was provided to substantiate this and not all heavy fuel oil is transported by sea to the UK and not all of this will necessarily suffer contamination. However it does not seem unreasonable to make some allowance for potential sea water contamination of heavy fuel oil prior to its use so that the implied emission standard for waste oil is no stricter than that for heavy fuel oil.

Accordingly, we propose a limit of 150 ppm to be an acceptable level of total halogens (the sum of chloride and fluoride) expressed in terms of chloride for Class G equivalent processed waste oil.

Gas oil should not be contaminated with sea water and therefore its equivalent should have virtually no chlorine. The Quality Protocol, therefore, proposes a very low limit for chlorine.

3.3.2 Sulphur

We propose a sulphur limit equal to that currently applied to Class G and Class D fuel oils ie, 1% and 0.1% respectively.

3.3.3 Metals

Evidence provided by the Waste Oil TAG demonstrated that unprocessed waste lubricating oils can contain elevated levels of zinc (up to 1000 ppm). They can also contain significant amounts of lead, copper and trace amounts of a range of other metals. Proposed heavy metal limits for the HFO equivalent processed oil in the Protocol take into consideration the EMRC report and the proposals made by TAG members (see Table above in section 3.3).

Gas oil is a distillate product and does not contain heavy metals. As such the limits we propose for the gas oil equivalent processed oil are set at the limit of detection.

3.3.4 PCBs

The TAG believed that PCBs should not be present in either virgin oils or the processed waste oil. Hence we propose a limit of <5ppm to take account of detection limits.

3.3.5 Performance Parameters

In order for users of the processed fuel oil (PFO) to be able to use it in the same way as the ordinary fuel it has been processed to replace, we propose that the PFO must comply with the limits for the following parameters as given in the extant version of BS2869.

- Flash point(^{o}C)
- Water content
- Ash content
- Carbon residue
- Total sediment
- Strong acid number

It should be noted that the proposed ash limit for processed waste oil is set at 0.2% (compared with a limit of 0.15% for heavy fuel oil). This is on the advice of Energy Institute who have developed the method for sulfated ash from processed waste oils. Their advice took account of the reproducibility of the new method.

4. Environmental Risk Management

The following table sets out the risks associated with processed fuel oil from the point of production until it is used.

Environmental Risk Management of PFO

Parameter	Risk Avoided	Regulatory Controls
Processing/production	- Detailed risk assessments carried out remain relevant to the final product - Regulator ensures compliance with protocol	- Activity subject to Environmental Permitting Regulations (EPR) (incorporates IPPCD, WFD, WID) - Compliance with specifications in the protocol - Records of input wastes and product analysis - Product registration under REACH
Transportation of PFO	- Accidental spillages	- Subject to national laws on the transport of inflammable materials
Storage of PFO at user site	- Contamination of soil and surface/ground waters	- Site permits requiring storage arrangements for any other liquid fuel
Usage of PFO as fuel	- Risk to the environment and human health	- Plants > 0.4 MW subject to EPR permits - Sulphur levels in PFO as allowed under EU Directive - Level of contaminants similar to fuel oils