Comments of Claude D. Convisser
to ASTM Work Item Number: WK21463, draft dated July 29, 2010
ASTM Subcommittee D02.P0
"Standard Specification for Triglyceride Burner Fuel"

Section 1.2: *"The fuels specified herein are not intended for blending with conventional fuel oils for this purpose."*

Triglyceride fuels are miscible with petroleum fuel oils. This is based on experience that Plant Oil Powered Diesel Fuel Systems, Inc. ("POP Diesel™") and our associates have using these fuels together. (hereinafter, "POP Diesel™'s experience"). See also "A Demonstration of Fat and Grease as an Industrial Boiler Fuel," University of Georgia (2002), page 2-4 (hereinafter "U. Georgia report"); letter from Phil Krepfl of AAA Pumping Service dated Sept. 20, 2010 ("Krepfl letter") (attached to these comments). POP Diesel™ sells commercial and residential burners approved by the German standard-setting organization TUV that run on 100 percent triglyceride fuels or any blend of triglyceride and petroleum fuels without the need for any pre-adjustment to the fuel pressure or other controls. Our technology is transferrable to large-scale industrial burners. Blending is commonplace in the triglyceride burner fuel market. POP Diesel™'s experience; Krepfl letter. Therefore, the above-quoted restriction is inaccurate and unnecessary and it should be deleted.

As an aside, I am not sure if the term "conventional fuel oils" is defined anywhere in the ASTM lexicon. Even if it is, I believe that what is meant by this term is more accurately, and less pejoratively, called "petroleum fuel oils." What is "conventional" is only a matter of convention, and convention can change over time. For instance, the present convention is to use petroleum in diesel engines; however, Rudolf Diesel intended his engine to run on peanut oil and the convention may be turning back towards biofuels, though this may take decades. **Section X1.4.4 *Viscosity*** separately mentions "conventional petroleum-based fuel oil," which I have proposed be deleted for other reasons, though the reasons stated in this paragraph would also apply to that Section.

Section 1.2: *"They are not intended for use in burners <0.32 GJ/h (0.3 × 10^6 BTU/h) such as residential burners or small pressure atomization burners nor are they intended for use in internal combustion engines or marine applications."*

Triglyceride fuels operate perfectly fine in burners with output of less than 0.32 GJ/h. POP Diesel™ sells burners approved by the German standard-setting organization TUV to run on 100 percent triglyceride fuels or any blend of triglyceride and petroleum fuels that produce energy output in this range and that are suitable for both commercial and residential use.

In addition, triglyceride fuel is suitable for use in internal combustion engines and marine applications, provided the correct equipment is installed and the fuel is managed properly. Whether or not Committee members accept POP Diesel™'s experience on these points at this time, there is no scientific or engineering reason for the Scope section to include the statement of non-intent quoted above and it should be deleted in its entirety.

Section 3.1.3: "*triglyceride burner fuel*, *n—any triglyceride, including recycled and unused cooking oil, greases, animal fats, and naturally occurring constituents of triglycerides including monoglycerides, diglycerides and free fatty acids, suitable for the generation of heat by combustion in a furnace or firebox as a vapor or a spray or a combination of both with little or no*
preconditioning other than preheating."

The term "triglyceride" is defined at **Section X1.3.1**. The clause in this definition that begins with the word "including" mis-uses terminology that already has a definition in the marketplace and meaning as a term of art. This clause mish-mashes terms, shows a lack of understanding of the marketplace for triglyceride fuels, and is, therefore, confusing. If you will look below to my comments on **Section X1.3 Terminology**, you will understand this comment. If the mention of "monoglycerides, diglycerides and free fatty acids" as "constituents of triglycerides" is essential, it ought to be done in the definition of triglycerides at **Section X1.3.1**.

In addition, this definition does not accord with the fact that if the triglyceride burner fuel derives from a waste source, then it has already been rendered. Rendering is a process that, indeed, involves "preconditioning," a term that is used in the definition above to exclude triglycerides from being used as a burner fuel. In other words, the definition stated above, in effect, excludes all waste sources of triglycerides from being burner fuels, since such feedstocks have already been rendered and therefore "preconditioned."

The simple way to avoid such confusion over this terminology is to delete the mis-informed attempt to specify triglycerides and shorten the definition of "triglyceride burner fuel" to omit the exclusion "preconditioning," as follows: triglyceride burner fuel is **"any triglyceride suitable for the generation of heat by combustion in a furnace or firebox as a vapor or a spray or a combination of both."** The fact that preheating may be necessary is stated separately in sections **5.3.1 Grand TBF5** and **5.3.2 Grade TBF6** and therefore, the mention of preheating may be deleted from this definition.

Section 5.3.1 Grade TBF5—*"a burner fuel comprised of commercial recycled and unused cooking oils, greases and rendered animal fats having a pour point below 21°C in accordance with Test Method D97. The requirements for this type of triglyceride burner fuel are presented in Table 1. This grade is intended for use in industrial burners and commercial boilers equipped*

with devices that use steam or compressed air to atomize fuel oil of higher viscosity. Preheating may be necessary in some types of equipment for burning this fuel and in colder climates for ease of handling."

Why is the term "commercial" cooking oils, etc., employed here? It is unnecessarily limiting, since triglyceride burner fuels may derive from household, as well as commercial, sources. If the use of "commercial" refers to the processing of the feedstock, a more accurate and appropriate term would be "rendered." However, as stated in the next paragraph, the best term to use would be the simple term "triglyceride," which is defined at **Section X1.3.1**.

I do not understand why this draft definition is restricted to "recycled and used" feedstock. Virgin or fresh vegetable oil is also a triglyceride and there is no reason why the definition of TBF in this Specification should exclude virgin or fresh vegetable oil that otherwise meets all of the requirements of Table 1.

For the reasons stated in my comments to **Section 3.1.3** above, the beginning of this draft definition states a mis-use of terminology, consisting of a mish-mash of terms already defined in the triglyceride fuel market, that is confusing and unnecessary.

For the reasons stated in my two sets of comments to **Section 1.2** above, I do not believe that this draft definition comports with the marketplace for triglyceride fuels in stating that "[t]his grade is intended for use in industrial burners and commercial boilers," when this fuel can be used just as well in residential burners that are already available on the market.

There are some boilers that "use steam or compressed air to atomize fuel" not because the fuel may be "of higher viscosity," as the draft definition specifies, but because this technique leads to a more efficient burn. There are some triglyceride fuels suitable for use in burners that are not necessarily "of higher viscosity." Furthermore, the phrase "of higher viscosity" is undefined; it implies a comparison of some kind that is never given anywhere in the draft Specification. For these reasons, it is advisable to delete the confusing and unnecessary "of higher viscosity" qualifier.

The only place where I could find mention of "boilers," other than in the draft definitions of the TBF grades, is in **Section 3.1.2.1**, which sets forth two typical applications for industrial burners, one of which is in an "industrial boiler." Since, as Section 3.1.2.1 states, an "industrial boiler" will by definition have a burner attached to it, there is no reason to throw in the term "boiler" in this draft definition.

In sum, the following definition of **TBF5** accords more accurately with the facts, while retaining the essence of the Specification: **"a burner fuel comprised of triglycerides having a pour point below 21°C in accordance with Test Method D97. The requirements for this type of triglyceride burner fuel are presented in Table 1. This grade is intended for use in burners equipped with devices that use steam or compressed air to atomize fuel oil. Preheating may**

be necessary in some types of equipment for burning this fuel and in colder climates for ease of handling." This definition should be used instead of the one in the draft.

Section 5.3.2 Grade TBF6: *"The extra equipment and maintenance required to handle this fuel grade may preclude its use in small and/or unattended installations."*

For the reasons stated in my two sets of comments to **Section 1.2** above, this statement is an unnecessary and unjustified limitation, made especially so by the fact that the preceding sentences state: *"The use of this grade may require preheating in the storage tank to permit pumping. Additional preheating at the burner may be necessary to permit satisfactory atomization."* In sum, the sentence quoted above is redundant of the passage preceding it, it implies an unjustified judgement that is not market-based, and it should be deleted.

All of my comments to **Section 5.3.1 Grade TBF5** above apply to the same language that is repeated in the draft definition of **TBF6**. Therefore, in sum, the following definition of **TBF6** accords more accurately with the facts, while retaining the essence of the Specification: **"a burner fuel comprised of triglycerides having a pour point equal to, or higher than, 21°C in accordance with Test Method D97. The requirements for this type of triglyceride burner fuel are presented in Table 1. This grade is intended for use in burners equipped with devices that use steam or compressed air to atomize fuel oil. The use of this grade may require preheating in the storage tank to permit pumping. Additional preheating at the burner may be necessary to permit satisfactory atomization."**

Section 9. Keywords

Additional, new terms that I propose should be defined in the Appendix **Section X1.3 Terminology** should be added to this list:

- waste grease
- brown grease
- black grease
- wastewater fats, oils and greases

My comments below to **Section X1.3** give the reasons for defining these terms in this Specification.

Table 1 and title of document:

The draft limitation on total acid number ("TAN") of 30.0 (roughly corresponding to a free fatty acid level of 15 percent) does not correspond with market conditions and is unjustified. Brown grease, which the market defines as having an FFA level of 50 percent or less, is widely used in burners. Krepfl letter; POP Diesel™'s experience. The draft TAN of 30.0 corresponds to the market's definition of yellow grease, which has an FFA level not exceeding 15 percent. POP Diesel™'s burner equipment is not restricted by FFA level and FFA's do not harm this equipment. Here are typical test results using POP Diesel™'s burner equipment:

Oil:	brown grease sample with FFA level of 34.1 %
Exhaust gas temperature:	166.6 °C
CO2	12.98 %
Exhaust loss	6.7 %
Excess air	1.19 %
O2	3.3
Ppm CO	2
Ppm CO undiluted	2
Efficiency	93.3 %
Soot	0.00 %

The TAN should be amended to accommodate triglyceride burner fuel with an FFA level of as high as 50 percent to accord with current market conditions and technology. If the TAN limit of 30.0 remains, then the title of the document should be changed to "Standard Specification for Yellow Grease Burner Fuel" and pertinent references in the document to "triglyceride burner fuel" should be changed to "yellow grease burner fuel."

Appendix **Section X1.2** states the justification for limits: *"This specification ... places limiting values on the properties of the triglyceride fuel oils in each grade believed to be of the greatest significance in determining the performance characteristics of the triglyceride fuel oils in the types of burners, storage, and delivery systems in which they are most commonly used."* Based on market conditions and facts, the performance characteristics of triglyceride fuel oils as they are presently, commonly used in burners do not relate to a TAN of 30.0 and there is no reason to have this limit, other than the arbitrary reason that it happens to correspond to the FFA level that defines yellow grease. Krepfl letter; POP Diesel™'s experience.

Section X1.2 Rationale. The first paragraph states the origins and history of the development of the Specification, but it fails to state any present or future rationale for the Specification. Except for the first sentence, this paragraph is written in the past tense.

I propose the following as a substitute for the first paragraph of this section: **"This standard is the result of a request from the Used Oil Management Association (a United States trade group) to develop a specification that defines and classifies triglyceride burner fuels. Fluctuating fossil fuel energy prices and the impetus to curb greenhouse gas emissions from**

fossil fuels create demand for renewable alternatives. Triglycerides derived from waste greases are already in use in residential, commercial and industrial burners. Local and state authorities have been rewriting permits to allow for their use. However, there are not yet any nationwide standards concerning their use."

Section X1.3 Terminology: Several of the definitions are incorrect and some additional terms need to be defined, as follows:

New term defined X1.3.? *waste grease* – a triglyceride consisting of used vegetable oil which may include animal fats and proteins.

The draft includes (incorrect) definitions of rendering, yellow grease, and brown grease, but fails to define the constituent term "grease." A correct definition of "waste grease," stated above, is necessary. This definition couples the word "waste" with "grease" to distinguish from the grease that is a petroleum product used as lubricant.

X1.3.4 "*rendering* – *a process of both physical and chemical transformation involving the application of heat, the extraction of moisture and the separation of fat."*

This is incorrect. Rendering, unlike, say, transesterification, is not intended to bring about a transformation and it does not fundamentally transform triglycerides. Rendering is not a chemical process, except for incidental effects that may occur. It does not lead to the separation of fat. A correct definition of rendering is **"the application of heat to waste grease or tallow that separates triglycerides from water and other impurities."**

X1.3.5 "yellow grease – *a grease made from used restaurant greases (fats and oils from cooking) or from rendering facility material."*

This is a made-up definition that is incorrect and inaccurate. Although yellow grease often comes from the fryer of a restaurant, the market definition of yellow grease does not depend on the feedstock's source, it may come from sources other than restaurants, and the term "rendering facility material" is vague and meaningless. Yellow grease is defined in the market as follows: **"waste grease that has a level of moisture, insolubles, and unsaponifiables of less than 2 percent and a free fatty acid level of less than 15 percent."** This definition should be used instead of the one in the draft. Additional descriptive language that is not inaccurate may be included: **"Yellow grease commonly originates from a restaurant fryer."**

X1.3.6 "brown grease – *waste vegetable oil, animal fat, grease, tec. Recovered from a waste water component called a grease trap. The grease is removed from wastewater sent down a restaurant's sink drain."*

This is a made-up definition that is incorrect and inaccurate. Although brown grease often derives from trap waste, the definition of brown grease does not depend on its source. Furthermore, the origins of wastewater used in this definition is incorrect. Wastewater that furnishes the material to make brown grease can come from the dishwasher drain, from a household sink drain, and from sewage entering a wastewater treatment facility. Lastly, this draft definition wrongly implies that brown grease may come directly from wastewater. It omits the intermediate step of rendering the trap waste to produce the brown grease.

Brown grease is defined in the market as follows: **"waste grease that has a level of moisture, insoluables, and unsaponifiables of less than 2 percent and a free fatty acid level of less than 50 percent."** This definition should be used instead of the one in the draft. Additional descriptive language that is not inaccurate may be included: **"Brown grease commonly derives from the waste that collects in a restaurant trap receptacle underneath the kitchen and dishwasher drains."**

New term defined X1.3.? black grease – waste grease that has collected and congealed in the sewage system.

This may be used as triglyceride burner fuel after additional processing.

New term defined X1.3.? wastewater fats, oils, and greases – waste greases that collect at a wastewater treatment facility, typically on the surface of a primary clarifier.

These may be used as triglyceride burner fuel after additional processing.

Section X1.4.1 *Pour point*: *"An increase in pour point can occur when triglyceride burner fuel is subjected to cyclic temperature variations that can occur in the course of storage."*

POP Diesel™ has never noticed this condition in our experience. I would be interested to see the scientific data supporting this statement. If there is not any, this statement should be deleted.

Section X1.4.4 ***Viscosity***: *"In the use of triglyceride burner fuel, [viscosity] is more significant than in the use of conventional petroleum-based fuel oil, in which it is highly significant."*

This statement states a normative value -- the "high significance" of the viscosity of conventional petroleum-based fuel oil" -- without giving any context. Why do we care? Why not simply state, instead, a fact, as follows: **"The viscosity of triglyceride burner fuel is usually higher than the viscosity of conventional petroleum-based fuel oil."** If this proposed change is accepted, I suggest placing this sentence after the following sentence, for better flow (viscosity, ha ha) of this paragraph: *"It indicates both the relative ease with which the fuel will flow, or can be pumped, and the ease of atomization."*

If the sentence quoted above is retained, for the reasons stated in the second paragraph of my first set of comments to **Section 1.2** above, I do not think it is advisable to use a term like "conventional," as in "conventional petroleum-based fuel oil" from the quote above, and I suggest that this word be deleted.

Section X1.4.4.1 ***Converting dynamic viscosity to kinematic viscosity***: This paragraph is confusing. For beginners, it is not clear why it starts with:*"Viscosity may <u>also</u> be determined using rotational or dynamic viscosity test methods."* Does this mean that these methods are different from any method cited in the preceding **Section X1.4.4 Viscosity**? If so, this should be clarified in the opening sentence. At the end of this paragraph's second sentence, I believe that there may be one too many uses of the word "density," where it states: *"... the density of the sample density in kg/m^3."*

Section X1.4.4.2 ***Viscosity/temperature range data***: *"The viscosity of both TBF5 and TBF6 fuel oils can change significantly with relatively small temperature differences in the range of temperatures at which the burner operates. For this reason, burner manufacturers and triglyceride fuel users should consider the viscosity characteristics of the range of potential triglyceride fuels very carefully."*

The wording of the second sentence quoted above is unnecessarily normative. Either burner manufacturers will allow their burners to be used with triglycerides or they will not. It is not up to this ASTM Committee to chastise them concerning their consideration of a particular kind of fuel. A more neutral and appropriate re-writing of this second sentence, which should be substituted for the one quoted above, is as follows: "**For this reason, burner manufacturers and triglyceride fuel users should be aware of the viscosity characteristics of triglyceride fuels under consideration."**

Section X1.4.4.2 ***Viscosity/temperature range data****: "Yellow grease in particular can be problematic in burning applications due to its inconsistent viscosity."*

This general statement is not true. It reflects a shortcoming of the equipment, rather than the fuel. Any irregularities in yellow grease's viscosity may be mitigated by use of the correct equipment. Testing experience shows that yellow grease works fine as burner fuel. U. Georgia report.

Section X1.5.1 ***Acid Number***: *"Acid number is used to determine the level of free fatty acids, processing or degradation by-products that may be present in triglyceride fuel. A high acid number has been shown to accelerate fueling system deposits, increase filter-plugging potential and may increase the likelihood for corrosion. Burner materials such as copper, brass, bronze or*
light gage carbon steel may have reduced service life due to corrosion when exposed to triglyceride burner fuels."

Acid number is used to determine the level of acid in the fuel, period. It does not determine the level of "processing or degradation by-products" in the fuel, which are undefined in the Specification. The term "processing" is a general term that is not defined elsewhere in the Specification, although a specific form of processing, "rendering," is. The term "degradation by-products" is not used anywhere else in the Specification. These nondescript terms should be avoided to prevent vagueness and confusion. Furthermore, since triglyceride fuel derived from waste grease or tallow contains what it contains, the term "by-product" is inaccurate, since the constituents of this triglyceride fuel will include whatever has been formed during its evolution.

Other than corrosion of the metallic parts listed, I question the source for the dangers of "a high acid number" recited in the quote above, that it will cause general corrosion and "accelerate fueling system deposits [and] increase filter-plugging potential." Is this statement, by chance, based on the experience of internal combustion engines with biodiesel? If so, this experience is not transferrable to the use of triglycerides as burner fuel and is like comparing apples and oranges. The acids are combusted in the burner; they do not sit in the burner components 24/7 and cause degradation when the machine is not in use, as they risk doing with biodiesel blended with No. 2 diesel in an internal combustion engine.

The focus on limiting the acid number reflects a misconception that the problem lies with the fuel. Instead, any problem, if one actually exists with the use of triglycerides in burners, lies with the use of inappropriate equipment.

Absent evidence disproving POP Diesel™'s experience described above, this section should be shortened, as follows**: "Acid number is used to determine the level of free fatty acids and other acids present. Burner materials such as copper, brass, bronze or light gage carbon**

steel may have reduced service life due to corrosion if exposed to high levels of acid in triglyceride burner fuels."

Section X1.7.2 ***Polymers****: "Both naturally occurring polymers and those from materials introduced in the rendering process may cause both soluble and insoluble polymers to be present in triglyceride burner fuels.*

* * *

Polyethylene from the rendering of packed out-of-date supermarket meats frequently survives the rendering process. Polymers are also present in flocculent used in dissolved air floatation systems in rendering facility wastewater treatment plants. The flocculent and accumulated fats, oil, and other impurities are frequently returned to the rendering process."

I believe that these sentences are based on unfamiliarity with the ordinary rendering process. A main cause of polymers in triglyceride fuel derived from waste sources is the process of rendering itself, and not "materials introduced in the rendering process." There are ordinarily not external "materials introduced in the rendering process" to a significant degree, and unless this phraseology is a euphemism for polymers created during and as a result of the rendering process, it should be deleted.

The three sentences appearing below the * * * in the quote above overstate the contribution that "materials introduced in the rendering process" make to polymers in triglyceride feedstocks. I have never seen "polyethylene from the rendering of packed out-of-date supermarket meats" survive the rendering process. If there is once in a blue moon a piece of polyethylene that finds its way into waste grease, it will contribute a minuscule amount of polymers to the triglyceride fuel, when considered in the context of the entire nationwide supply of such fuel.

I am not an expert in "dissolved air floatation systems in rendering facility wastewater treatment plants." However, my familiarity with the overall grease industry tells me that such systems are in use in rendering plants that contribute only a small portion of the total waste grease and tallow supply in the United States. I similarly believe that any "flocculent and accumulated fats, oil, and other impurities" that are "returned to the rendering process," contribute, in the grand scheme of the nationwide supply of triglycerides derived from waste sources and the degree to which this supply is exposed to "dissolved air floatation systems," a small amount of the polymers found in the end product fuel.

Therefore, I believe that a more accurate paragraph describing polymers in triglyceride burner fuels would delete the three sentences appearing below the * * * in the above quote and would substitute the following two sentences for the first sentence quoted above: **"Triglycerides contain some naturally occurring soluble and insoluble polymers. Foreign substances may also produce polymers in triglyceride fuels derived from waste sources."**

Thank you for your consideration of the foregoing.