final report

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A BASIC MANUFACTURING FEASIBILITY PLAN FOR ADDITIVES

This is an MLA Donor Company funded project

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EXECUTIVE SUMMARY

Commissioned by the Midfield Group, MQC Management (MQCM) has carried out a preliminary development of a manufacturing plan for the additives used in turning tallow into a substantial component of a biodiesel fuel mixture.

In so doing, MQCM has suggested a strategy which is predicated on initial toll manufacture followed by an in-house manufacturing facility, at least in the context of the Australian market. However, a backward step must be taken immediately to improve the reliability and quality of existing technical and commercial assumptions and data. Their current status is such that commercialisation approaches and decisions run the risks of being wrongly decided and followed, leading to possible disastrous consequences. A case in point is the price list of raw materials as published and used in the existing business modelling (Simon Mathew *et al* "Information Collection for Funding Model Development", undated report (2007?)). The list relies heavily on quotations made on

inappropriate batch/container sizes and thus may bear no relations to real situations since the scaling up work and market conditions have not been firmly established. The product recipe has not been determined upon and "frozen". This oversight leads to confusion and inability for the business to proceed with essential approvals should these be needed. In addition, a manufacturing strategy would need to be iteratively associated with a commercial model which would "fix" or assume certain parameters (product forms and ranges, production outputs and schedules, pricing policy, etc)

For at least the above reasons, it is not possible at this time to for a detailed manufacturing plan to be proposed with certainty. MQCM recommends that this report be considered as a starting point for a process of review of all facets of the project. The recommendation comes with a list of "must do's" starting with the overhaul of the commercialisation model, based on what has been achieved technically and commercially. One possible firm starting point is making B20 the final and technically-feasible product and postulating a realistic estimate as to the maximum annual production that is available to the market. Together with the generation of additional technical data ("frozen recipe", raw material costs and sourcing, scaling-up process, distribution mechanisms, approval requirements and timings, etc), the commercialisation model can help the investigation of sensitivities and scenarios and thus help with the decision- making on the viability of the project.

1. BACKGROUND/METHODOLOGY:

The following background has been provided by MLA and Midfield:

"*Biodiesel is an alternative to petroleum diesel fuel made from renewable resources such as vegetable oils, animal fats or algae. It has very similar combustion properties to petrodiesel, and can be used as a direct substitute. However, its use is currently limited as an additive to petroleum diesel, improving the otherwise low lubricity of ultra-low sulphur petrodiesel fuel. A growing number of fuel stations throughout Australia and around the world are making biodiesel available to consumers, and a growing number of large transportation fleets use some proportion of biodiesel in their fuel. Tallow is a potential feedstock for the biodiesel industry, but suffers from poor cold flow properties.*

MLA, FPE & Midfield funded P.PSH.0331 "Modification of tallow for improved performance as biodiesel" which developed an additive that when added to tallow based biodiesel resolves the cloud point issues (in lab) that develops in lower temperatures, clogging diesel engines. Tallow based biodiesel (in a B20 mix) currently crystallise and can clog motors at approx 4º. The additive, a mixture of three chemicals (Attachment 1) showed in lab that the use of the biodiesel can be extended down to 0 º (this also means it had an effect on the diesel used, which had a lower limit of use down to 2º). Effectively the additive improved the temperature use of the biodiesel and diesel. An Australian provisional patent application has been lodged.

The research to date has proven the performance of tallow biodiesels in low temperatures and that the cloud point issues can be successfully resolved. An additive for tallow based biodiesel has been formulated, however, further research is required for additive to meet Australian Biodiesel Standards, before release onto the Australian market. The research required has been mapped out and is currently being priced. In order for MLA and the partners to evaluate the appropriate way forward, including justifying investment into the further research required, a commercialisation scenario analysis is necessary. This analysis will explore different commercialisation models and scenarios and assist the partners to determine the best way forward for commercialisation and adoption into the market.

If this technology is successfully commercialised, the biodiesel industry will be able to utilise tallow as a feedstock throughout Australia, year round. This would make a significant impact on demand for tallow. If total Australian tallow production (600,000 tonnes/year) were converted to biodiesel this would represent approximately 8% of Australia's current diesel demand. This technology will also assist industry in reducing their environmental footprint."

As part of this commercialisation plan, MQC Management has been commissioned by MLA to consider and formulate a basic strategy for the manufacture from the g-scale mentioned in Attachment 1 to a scale that a prospective toll manufacturer can work with or a reasonably-skilled engineering team can start the required process design. MQCM further understands that such a strategy should include the preliminary testing and

regulatory approval requirements. It would form an integral part of the commercialisation strategy.

In so doing, MQCM has critically assessed the current technical data being made available, judged their fitness into the also available commercialisation model, and made recommendations as to the way forward.

POSITIONING OF THE MANUFACTURING STRATEGY

Figure 1 explains in key terms the inter-relationship between the manufacturing and the commercialisation strategies. It shows that with it being in the central position, the quality and relevance of the manufacturing strategy are very much dependent on the way the commercialisation strategy is mapped out. In particular, the commercialisation plan arising out of such a strategy must spell out the following:

- Product form/design
- Production size, timing and schedule; and
- Distribution and marketing routes (when, to whom, how much product etc)

In an iterative loop, the manufacturing plan/strategy will provide:

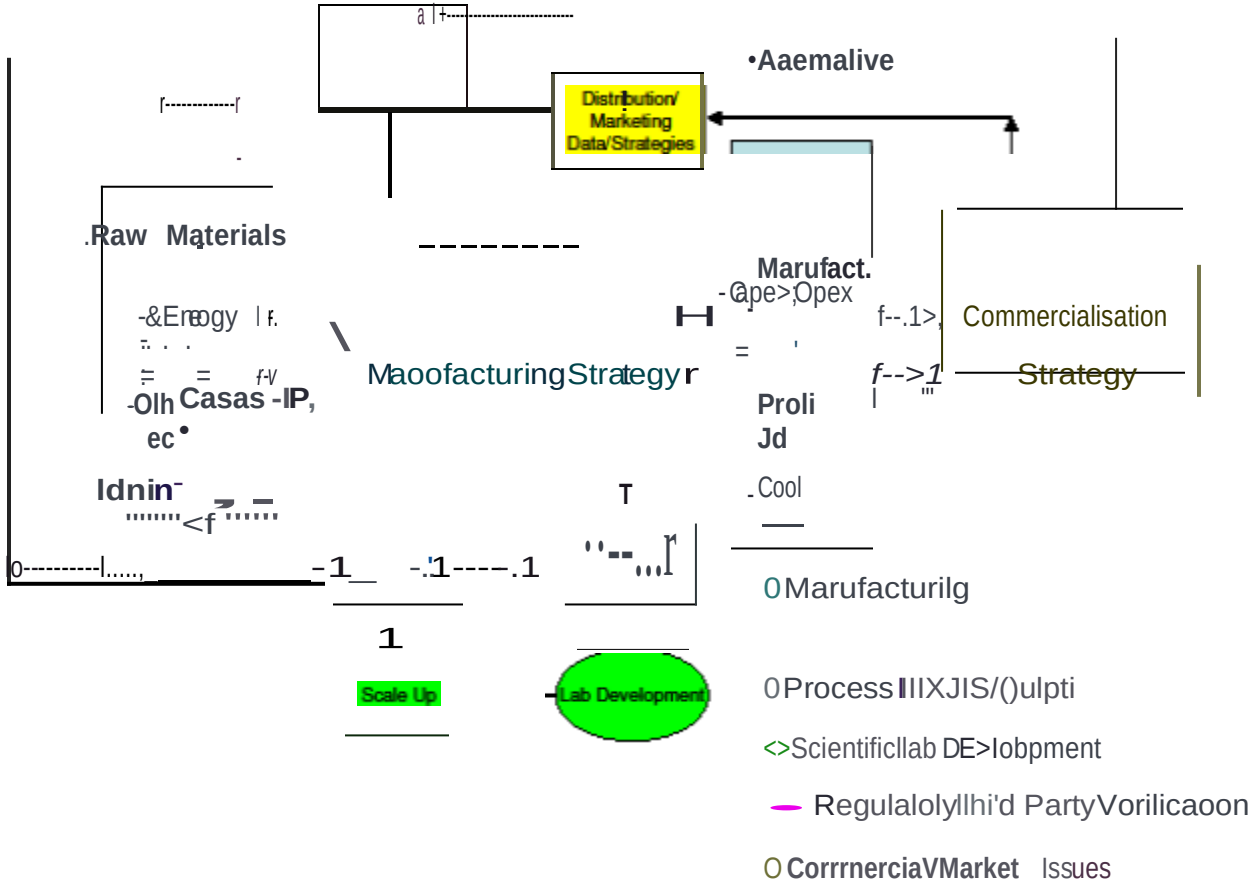
- Alternative manufacturing routes and attendant production costs
- Production process and associated capex/opex; and
- Production schedule

Critically, the manufacturing strategy should have the following inputs:

- Scaling-up information to a suitable scale that can be translated into a real process;
- Mass and energy balances;
- Labour and utilities costs as per alternative routes;
- All the SH & E information, including MSDS of all raw materials;
- Raw materials costs and sourcing; and
- Other costs (IP, administration, storage, quality control etc).

Above all, the data and inputs must be of the quality on which various scenarios and sensitivities can be played out.

Figure 1 - Positioning of The Manufacturing Strategy



DEVELOPMENT OF A MANUFACTURING PLAN

Figure 2 summarises the key steps in a manufacturing plan with two alternative routes: toll or in-house manufacture, one route not necessarily being at the exclusion of the other. In general, toll manufacture is normally chosen at the beginning of the project, when:

- There is a preference for operating than capital expenses;
- The required product quantity may not justify a dedicated production facility;
- The business has not acquired a manufacturing skill base; and
- There are specialist toll manufacturers (especially in biotechnology) that could help, among other things, to expedite the dissemination of the product into the market with a lower manufacturing risk profile.

The in-house route is preferred when:

- The market is large enough, or will be large enough within a given timeframe to ensure that an economically sized production facility could be justified;
- The skills and experiences required to build, operate and maintained such a facility are available;
- There is a desire to gain and keep the skills acquired through the manufacture of the product;
- There is a clear advantage in costs – generally, the cost of production per unit could be as much as being 20% higher if it is toll-manufactured; and
- There is a risk of IP leakage through toll manufacture.

There is a third route that allows the additives to be manufactured and sold back to the business on a licence. This has merit, especially when the licensed manufacturer can see a way to incorporate the products into its own portfolio. However it is not being considered at this time.

All three routes, however, require a manufacturing process that has been properly scaled up to a point that information required for any necessary approval process (to manufacture, use or sell the product) is available. In addition, performance (in the case of biodiesel, CP, CFFP and Cold Soak Filtration Tests) and marketing-linked (long-term use in engines, stability in storage etc) test results must also be obtained

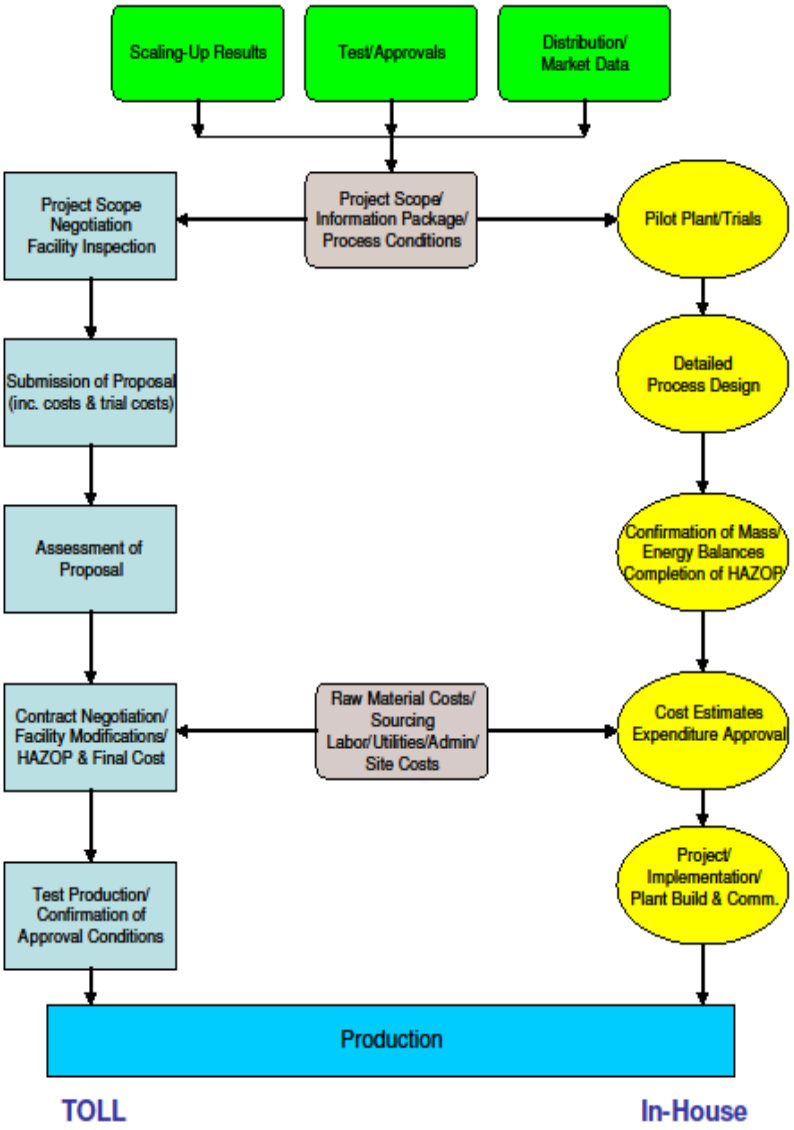


Figure 2 – Development of The Manufacturing Strategy

ADDITIVES MANUFACTURE – WHAT CANNOT BE DONE NOW?

At this stage, a process scope cannot be issued for the manufacturing plan to be implemented in either of the two routes presented in Figure 2. The key reasons are as follows:

- There is no scaling up data apart from the laboratory procedures described in Attachment 1. This is most important since no production process can be determined/developed until the production has been carried out at a reasonable scale which can be repeatable with reliable mass and enrgy balances. Data on repeatability/quality are needed for approval/registration purposes;
- The “recipes” have not been frozen, and although a 25% concentrate of additives appears to be the final product prior to blending to a B20 diesel, no optimisation (amount of solvents, types of solvents) even on the laboratory scale has been carried out to minimise work and costs;
- Regulatory approval procedures may not be required for the esters but it appears to be a must for the polymer mix (P 4 -7). The quality and repeatability of production data from the scaling up operation must be geared to satisfy the approval requirements – For the procedures to be followed to ascertain if the additives have been registered please refer to Attachment 2 – Response from NICNAS. According to the database available through the Australian Inventory of Chemical Substances, the two esters have not been registered as imported into or manufactured in Australia as *industrial chemicals*. P 4 -7 does not yet have a CAS number and is definitely not registered or reported anywhere apart from MLA/Flinders University internal reports. However, it must be noted that both esters are lokely to be involved in the manufacture/formulation of cosmetics or pharmaceuticals and may have been registered under one of the three other registration/approval schemes in Australia;
- Some performance tests have been carried out with excellent results. However, these test results may not be relevant as the product recipes (and thus qualities) have not been “frozen” and the quality of the final blend established. Attachment 3 lists the standards and/or tests that biodiesel fuels in Australia must satisfy;
- Attachment 4 lists other standards/tests that a biodiesel must satisfy if it is used in the USA/Europe/North America. Standards for EU are currently under review, although the existing one is also listed. Note that at least one of the tests (Cold Soak Filtration Analysis) hass at present a geographically mandatory effect only.

ADDITIVE MANUFACTURE – WHAT DATA ARE PRESENTLY AVAILABLE?

Toll Manufacture:-

Orica Specialty Chemicals, a business within the Orica Group, has been assisting with the toll manufacture scenario, and is on hand to take the process inititally to the 400- litre vessel stage (perhaps with a production rate of around 10-15 kg/batch?), taking the current laboratory yield as the starting point . However, it has refused to commit

firmly to this scale unless certain optimisation and scaling up data are made available in a properly constituted process/project scope. It recommends that the process be scaled up to around the 5 – 20 litre batch size, preferably with the process being carried in one single vessel, with the key solvent be optimised both in volume and type so it can be part of the final concentrate (with concentration still be a possible production step) and it would be possible to eliminate effluent. Attachment 5, issued to Flinders University early in December 2008, lists most of the required data and together with following-up emails to Dr Stephen Clarke the work, constitute a request for an R & D Proposal from the Univeristy to MLA. This proposal has been submitted but should be revised in light of the recommendations made in this report.

If the toll contract is possible, the starting point for negotiation is a fee of around $8,000 to $10,000 per batch of product up to the vessel size of 3,000 litres. Other cost plus items are raw materials, storage/packaging of the concentrate, treatment/disposal of any off-specs materials and effluent, and development batches (around 2 or 3 trial batches).

Orica Specialty Chemicals will apply all requirements re quality of products to comply with approval criteria.

It should be noted that the toll manufacture arrangements could be the stepping stone to either the in-house or licensed manufacture scenarios. However, at this stage, it should be inserted into the commercialisation plan/strategy as an one-off cost.

In-house Manufacture

In the absence of more concrete process data, MQCM has estimated that the capital required for a plant that produces 1300 TPA of Polymer 4-7, 90 TPA of Sucrose 5- oleolate and 45 TPA of sucrose 5-myristate is around A$6 million. The plant will consist of:

- One dedicated 5000-litre reactor for Polymer 4-7 operating on a 3-shift/day basis producing 4 batches/day at 1 tonne/batch;
- One dedicated 1000-litre reactor for the two esters, producing 1 tonne of either product per day;
- Associated storage vessels for tallow, products and the key solvents (toluene and acetone);
- Associated utilities equipment at battery limits (cooling, steam, electricity, demineralised water supplies); and
- A small office/quality control laboratory.

The following additional assumptions can be

made:

- Reactions are to be carried out in the single vessels provided. Some solvent recovery is allowed through distillation/condensation but there is no effluent;
- The concentrate (25%) solution of additives is blended with tallow on site and then loaded on IBC or tankers to deliver to the final users or to a blending facility where B20 biodiesel is constituted

The plan should be manned on a 4 shift roster, with the day shift having 2 operators and the other two shifts one or two depending on the site. These data would be sufficient for the manufacturing costs to be inserted into any financial models. The key issue here is the material balance which decides the quantities of raw materials and products. This has not been determined with a reasonable degree of certainty since the scaling up has not been completed.

Sensitivities to Raw Materials Prices

The financial modelling work (BDO Kendall) using the raw material costs as collected by Simon Mathew *et al* (in "Information Collection for Funding Model Development", undated report (2007?)) concluded that (with other assumptions) the NPV over 10 years was A$-12.1 million, and over this period, the project would not be profitable at any stage/year should the consortium choose the direct commercialisation route.

There are always great variations in the costs of raw materials as these are often dependent on the required quality of the raw materials being sourced, the supply and demand situation on the market and the sizes of the orders. The costs sourced in 2007 (?) and used in the financial case therefore are only relevant to that time.

While there is still much to do to optimise the raw material costs, it is believed with diligence and some efforts, it is possible to source materials at much reduced delivery prices than those obtained. For example, maleic anhydride is currently available at
~A$1200/tonne CIF Australian main ports compared to A$2839/tonne used in the model. DMF, another key raw material, can be bought (with actual quotations) now for A$1530/tonne vs A$2539/tonne.

Overall, it is possible to source raw materials at at least 80% of the prices used in the model on an overall basis. Figure 3 shows the sensitivity of the financial return on the raw material costs with the cost structure and other assumptions used in the BDO as a base case.

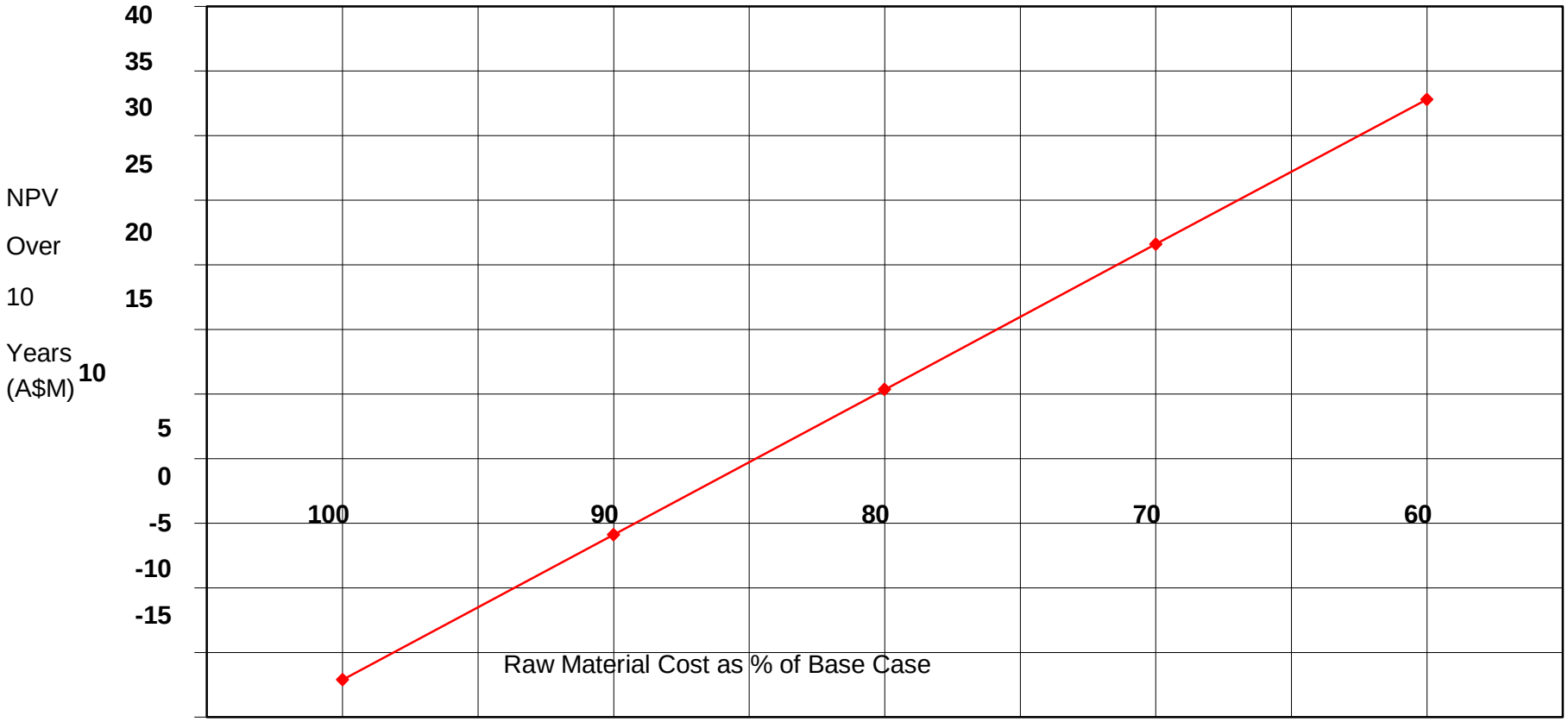


Figure 3 – Sensitivity of Financial Case on Raw Material Costs

RECOMMENDATIONS

It is clear to MQCM that at present, while the mechanism behind the financial analysis as presented by BDO Kendall is sound, the inputs into the modelling are not robust enough for the outputs to be used in the decision making process.

To partly improve the reliability of the model and to get to a Go/No Go position, technologically MQCM recommends that:

- The commercialisation strategy be reviewed to validate assumptions based on market size, market acceptance, product specifications, rate of entry and all associated costs – most importantly the likely costs of raw materials;
- The R & D program be re-tuned to ensure that the tasks of process development and scaling-up are properly and immediately optimised to arrive at a viable and repeatable process to produce the blend of the quality and at the rate that the market wants. The optimisation and scaling-up should include one vessel reaction trials to see if effluent can be totally avoided. Most importantly, the milestones should be directed towards the completion of the manufacturing processes and their optimisation. If Flinders University is not capable of carrying out the work, then another organisation or mechanism must be investigated. In general, the R & D/Scaling Up/Process Development Program should be tightly managed to ensure the delivery of milestones;
- There must be a "freezing up" of the product manufacturing process once the performance of the also frozen final blend (B20?) with appropriate levels of additives satisfies the relevant standards and customers' expectations.

The above two actions should lead to:

- A re-assessment of all raw material requirements leading to a proper sourcing plan that would deliver a realistic pricing structure and thus realistic costs of production.
- The beginning of the approval process, perhaps for the polymer only, and probably for all three additives.
- The approximated cost of the final blend that would withstand sensitivity analyses through different scenarios.
- And finally, to a "Go/No Go" decision.

ATTACHMENT 1 – LABORATORY PRODUCTION PROCEDURES FOR ADDITIVES

1. Procedure for making polymer P4-7

1.1 Raw Materials:

Lauryl acrylate
Stearyl Acrylate
Maleic Anhydride
Toluene
Benzoyl Peroxide

1.2 Equipment

- Vessel with heating coils and mixer
- Drying oven operated under nitrogen purge.

Lauryl acrylate (LA) (4.81g, 0.02 mol), stearyl methacrylate (SM) (2.71g, 0.008 mol, 3.13 ml) and maleic anhydride (MA) (1.96g, 0.02 mol) were placed in a 50 ml jar with toluene (12.5 ml). Using a magnetic flea, the components were mixed at 60 °C for 10 minutes on a hotplate. Benzoyl peroxide (0.12g, 0.005 mol) was then added and mixed for 2 minutes at 60 °C. The jar was then removed from the hotplate and placed in an oven at 80 °C overnight. The oven was connected to a nitrogen line and the oven was purged at a low flow rate.

· Higher molecular weight polymers were obtained using the new method
· High polydispersity (PDI> 2) was evident in all synthesized polymers

2. Synthesis of Sucrose-5-Myristate.

2.1 Raw Materials:

Sucrose
Dry DMF
Dry Pyridine Myrsitoyl
Chloride Acetone
Sodium bicarbonate
Sodium sulphate

2.2 Equipment

- Vessel with condenser, mixer, heating and cooling
- Filter
- Evaporator/high vacuum distiller

Sucrose (1.71 g, 0.005 mol) and dry DMF (5 ml) were heated in a 3 neck 250mL RBF (equipped with a condenser, thermometer and pressure equalising dropping funnel) with a heat gun until solution was achieved. Dry Pyridine (0.03 mol, 2.86 g, 2.43 ml) was added and the solution cooled to 60oC. A solution of myristoyl chloride (0.025

mol, 6.17g, 6.8 ml) in acetone (15 ml) was added dropwise to the vigorously stirred solution over a 30 min period. After the addition of the acid chloride the solution was stirred at 60oC for 1 hour, cooled to room temperature and acetone (75 ml) added. Sodium bicarbonate (2.5 g) and water (0.125mL) were added to the flask to decompose the pyridine hydrochloride by-product. After the evolution of CO2 ceased, Na2SO4 to remove water and mixture filtered through a sintered (G3 or G4) funnel. The solvent removed by rotary evaporation, then high vacuum distillation (water bath 45oC) before drying on high vacuum. The average yield was 7.6 g.
Synthesis of Sucrose-5-Oleate.

3.Synthesis of Sucrose-5-Oleate.

3.1 Raw Materials

Sucrose
Dry DMF
Dry Pyridine
Oleoyl Chloride
Acetone
Sodium bicarbonate
Sodium sulphate

3.2 Equipment

- Vessel with condenser, mixer, heating and cooling
- Filter
- Evaporator/high vacuum distiller

Sucrose (1.71 g, 0.005 mol) and dry DMF (5 ml) were heated in a 3 neck 250mL RBF (equipped with a condenser, thermometer and pressure equalising dropping funnel) with a heat gun until solution was achieved. Dry Pyridine (0.03 mol, 2.86 g, 2.43 ml) was added and the solution cooled to 60oC. A solution of oleoyl chloride (0.025 mol, 7.52g, 8.27 ml) in acetone (15 ml) was added dropwise to the vigorously stirred solution over a 30 min period. After the addition of the acid chloride the solution was stirred at 60oC for 1 hour, cooled to room temperature and acetone (75 ml) added. Sodium bicarbonate (2.5 g) and water (0.125mL) were added to the flask to decompose the pyridine hydrochloride by-product. After the evolution of CO2 ceased, Na2SO4 to remove water and mixture filtered through a sintered (G3 or G4) funnel. The solvent removed by high vacuum distillation (water bath 45oC) and dried on high vacuum. The average yield was 8.5 g.

ATTACHMENT 2 - RESPONSE FROM NICNAS ON THE NEED TO REGISTER ADDITIVES

Further to your email enquiry, we advise that NICNAS deals with the regulation of industrial chemicals contained in a product, and not with product mixtures per se. Indeed section 6(1)(g) of the *Industrial Chemicals (Notification and Assessment) Act 1989* excludes "a mixture" from its definition of "chemical".

Accordingly and rephrasing your query, the appropriate question is whether notification is required of any of the chemicals contained in your bio-fuel mixture, namely:

- Sucrose oleate (25496-92-8);
- Sucrose myristate (27216-47-3);
- Mixture of acrylic-based polymers (*chemical identities not specified*);

in Mineral diesel (*source not specified*) as the solvent,

and possibly, other solvents involving:

- Xylenes (1330-20-7, *mixture of isomers*)
- Toluene (108-88-3).

For the purposes of the Act, notification and assessment is generally required for a "new industrial chemical".

A chemical not listed on the *Australian Inventory of Chemical Substances* (AICS) is considered to be a "new" industrial chemical.

Hence, the question raised in your query is whether the above chemical ingredients in your bio-fuel mixture are listed on the Inventory.

The Inventory consists of a non-confidential section and a confidential section. You have search access to the non-confidential (public) AICS by using the online search tool available at http://www.nicnas.gov.au/Industry/AICS/Search.asp. Useful search guidance notes are provided herein.

Please note, it is preferable to search the Inventory using a CAS registry number. Generic chemical names, such as " Mixture of acrylic-based polymers" will produce a negative search result. We therefore recommend that you obtain more chemical information regarding the identity or identities of the acrylic-based polymers.

Should you require NICNAS to do this non-confidential AICS, you will need to submit an AICS-4 form, which required payment of an administrative fee (AUD$30) and a search fee (AUD$35) assessed per chemical. The form is downloadable from http://www.nicnas.gov.au/Forms/AICS/FormAICS-4NC_PDF.pdf.

If a search produces a 'no result' then to confirm the chemical is not listed on the Inventory you would need to submit a request for searching the confidential AICS. This search request is 'free' and the AICS-5 form is downloadable from http://www.nicnas.gov.au/Forms/AICS/FormAICS-5C_PDF.pdf.

Then, it is the combination result of searching the non-confidential and confidential section, which determines whether the chemical is a “new” industrial chemical or an “existing” industrial chemical. The latter, subject to any condition of use, would be available for import or manufacture of the chemical into Australia.

If it is established that the chemical is a “new industrial chemical”, the **next step** is to determine whether the chemical might be exempt form notification. For example, subsection 21(4) of the Act provides for the introduction (import or manufacture) of up to 100Kg per annum of a “new” industrial chemical without an assessment provided the chemical meets certain safeguards. You should advise NICNAS if you intend to manufacture a chemical under this section as certain obligations apply.

Finally, there is a separate “registration” requirement for all persons who import or manufacture a chemical for commercial purposes within the annual registration year, which runs from 1 September to 31 August in the following year. This requirement of company “registration” is different from the notification and assessment requirement to NICNAS involving “new” industrial chemicals.

We trust that the above sufficiently addresses your enquiry. If you have further questions, please do not hesitate to contact us.

Regards

Dr Curtis F Crasto

AICS Manager

ATTACHMENT 3 – FUEL STANDARD (BIODIESEL) DETERMINATION 2003 AS AMENDED

Fuel Standard (Biodiesel) Determination 2003

as amended

made under section 21 of the

Fuel Quality Standards Act 2000

This compilation was prepared on 4 September 2006
taking into account amendments up to *Fuel Standard (Biodiesel) Amendment Determination 2004 (No. 1)*

The text of any of those amendments not in force on that date is appended in the Notes section

Prepared by the Office of Legislative Drafting and Publishing,
Attorney-General's Department, Canberra

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Contents

1 Name of Determination [*see* Note 1]

This Determination is the *Fuel Standard (Biodiesel) Determination 2003*.

2 Commencement [*see* Note 1]

This Determination commences on gazettal.

3 Definitions

In this Determination:

ASTM International means the standards development organisation of that name.

biodiesel means a diesel fuel obtained by esterification of oil derived from plants or animals.

Energy Institute means the standards development organisation of that name.

European Committee for Standardisation (CEN) means the standards development organisation of that name.

4 Fuel standards for biodiesel

(1) Biodiesel that contains a substance mentioned in the following table must not contain more than the amount mentioned for the substance from the date mentioned for the substance.

Item	Substance	Amount	Date
1	Sulfur	50 mg/kg	18 September 2003
2	Sulfur	10 mg/kg	1 February 2006
3	Sulfated ash	0.020% mass	18 September 2003
4	Carbon residue — 10% distillation residue; or	0.30% mass	18 September 2003
	Carbon residue — 100% distillation sample	0.050% mass	18 September 2003
5	Water and sediment	0.050% vol	18 September 2003
6	Phosphorus	10 mg/kg	18 September 2003
7	Free glycerol	0.020% mass	18 September 2004
8	Total glycerol	0.250% mass	18 September 2004
9	Metals — Group I (Na, K)	5 mg/kg	18 September 2004
10	Metals — Group II (Ca, Mg)	5 mg/kg	18 September 2004
11	Methanol	0.20% (m/m)	18 December 2004

(2) A property of biodiesel mentioned in the following table must meet the specification mentioned for the property from the date mentioned for the property.

Item	Property	Specification	Date
1	Density at 15°C	860 to 890 kg/m^3	18 September 2003
2	Distillation T90	360°C (max)	18 September 2003
3	Viscosity mm^2/s	3.5 to 5.0 @ 40°C	18 September 2003
4	Flashpoint	120.0°C (min)	18 September 2003
5	Copper strip corrosion (3hrs @ 50°C)	(a) if the biodiesel contains no more than 10 mg/kg of sulfur — Class 1 (max) (b) if paragraph (a) does not apply — No. 3 (max)	18 December 2004
6	Ester content	96.5% (m/m) (min)	18 September 2003
7	Acid value	0.80 mg KOH/g (max)	18 September 2003
8	Total contamination	24 mg/kg (max)	18 September 2004
9	Cetane number	51.0 (min)	18 September 2005
10	Oxidation stability	6 hours @ 110°C (min)	18 September 2004

5 Testing methods

(1) Compliance with the standard set out in section 4 for the substance or property is determined by the testing method, as in force on 18 December 2004, for the substance or property in the following table:

Item	Substance or property	Testing method
1	Acid value	ASTM D664
2	Methanol	prEN 14110
3	Carbon residue — 10% distillation residue	EN ISO 10370
4	Carbon residue — 100% distillation sample	ASTM D4530
5	Cetane number	EN ISO 5165, ASTM D613, ASTM D6890

Item	Substance or property	Testing method
		or IP 498/03
6	Contamination (total)	EN 12662 or ASTM
7	Copper strip corrosion	(a) for specification Class 1 (max) — EN ISO 2160 or ASTM D130 (b) for specification No. 3 (max) — ASTM D130
8	Density	ASTM D1298 or EN ISO
9	Distillation T90	ASTM D1160
10	Ester content	prEN 14103
11	Flashpoint	ASTM D93
12	Glycerol (free)	ASTM D6584
13	Glycerol (total)	ASTM D6584
14	Metals — Group I (Na, K)	prEN 14108 and prEN 14109
15	Metals — Group II (Ca, Mg)	prEN 14538
16	Oxidation stability	prEN 14112 or ASTM D2274 (as
17	Phosphorus	ASTM D4951
18	Sulfur	ASTM D5453
19	Sulfated ash	ASTM D874
20	Viscosity	ASTM D445
21	Water and sediment	ASTM D2709

(2) For subsection (1):

(a) ASTM followed by an alphanumeric code means the testing method developed by ASTM International under the alphanumeric code; an

(b) prEN, EN and EN ISO followed by a number means the testing method developed by the European Committee for Standardisation (CEN) under the code and number; and

(c) IP, followed by a number, means the testing method developed by the Energy Institute under the code and number.

Notes to the *Fuel Standard (Biodiesel) Determination 2003*

Note 1

The *Fuel Standard (Biodiesel) Determination 2003* (in force under section 21 of the *Fuel Quality Standards Act 2000*) as shown in this compilation is amended as indicated in the Tables below.

Table of Instruments

Title	Date of notification in *Gazette*	Date of commencement	Application, saving or transition
Fuel Standard (Biodiesel) Determination 2003	19 Sept 2003 (*see Gazette* 2003, No.	19 Sept 2003	
Fuel Standard (Biodiesel) Amendment Determination 2004 (No. 1)	8 Dec 2004 (*see* No. GN 49)	Ss. 1–3 and Schedule 1: — *Gazette* 2004, 8 Dec 2004 Schedule 2: 18 Dec 2004	

Table of Amendments

ad. = added or inserted am. = amended rep. = repealed rs. = repealed and substituted

Provision affected	How affected
S. 3.....	am. 2004 No. 1
S. 4.....	am. 2004 No. 1
S. 5.....	am. 2004 No. 1

ATTACHMENT 4 – BIODIESEL STANDARDS

1. KEY STANDARDS

Biodiesel Standards		EUROPE	GERMANY	USA	PETROLEUM DIESEL
Specification		EN 14214:2003	DIN V	ASTM D 6751-	EN 590:1999
Applies to		FAME	FAME	FAAE	Diesel
Density 15°C	g/cm³	0.86-0.90	0.875-0.90		0.82-0.845
Viscosity 40°C	mm²/s	3.5-5.0	3.5-5.0	1.9-6.0	2.0-4.5
Distillation	% @ °C			90%,360°C	85%,350°C - 95%,360°C
Flashpoint (Fp)	°C	120 min	110 min	93 min	55 min
CFPP	°C	* country specific	summer 0 spr/aut -10 winter -20		* country specific
Cloud point	°C			* report	
Sulphur	mg/kg	10 max	10 max	15 max	350 max
CCR 100%	%mass		0.05 max	0.05 max	
Carbon residue (10%dist residue	%mass	0.3 max	0.3 max		0.3 max
Sulphated ash	%mass	0.02 max	0.03 max	0.02 max	
Oxid ash	%mass				0.1 max
Water	mg/kg	500 max	300 max	500 max	200 max
Total contaminatio	mg/kg	24 max	20 max		24 max
Cu corrosion	3h/50°C	1	1	3	1
Oxidation	hrs;110°C	6 hours min		3 hours	N/A (25
Cetane number		51 min	49 min	47 min	51 min
Acid value	mgKOH/g	0.5 max	0.5 max	0.5 max	
Methanol	%mass	0.20 max	0.3 max	0.2 max or Fp	
Ester content	%mass	96.5 min			
Monoglyceride	%mass	0.8 max	0.8 max		
Diglyceride	%mass	0.2 max	0.4 max		
Triglyceride	%mass	0.2 max	0.4 max		
Free glycerol	%mass	0.02 max	0.02 max	0.02 max	
Total glycerol	%mass	0.25 max	0.25 max	0.24 max	
Iodine value		120 max	115 max		
Linolenic acid ME	%mass	12 max			
C(x:4) & greater	%mass	1 max			

unsaturated esters					
Phosphorus	mg/kg	10 max	10 max	10 max	
Alkalinity	mg/kg		5 max		
Gp I metals (Na,K)	mg/kg	5 max		5 max	
GpII metals (Ca,Mg)	mg/kg	5 max		5 max	
PAHs	%mass				11 max
Lubricity / wear	µm at				460 max
		EUROPE	**GERMANY**	**USA**	**PETROLEUM**

2. OTHER STANDARDS/TESTS

* ASTM 6217 - Cold Soak Filtration Test Required for Biodiesel Fuels (so far mandated in Minnesota and Colorado, USA only)

ATTACHMENT 5 – PART OF THE REQUIREMENTS THAT AN R&D PROGRAM MUST FULFILL – AS ISSUED TO FLINDERS UNIVERSITY

Template for Report to Toll Manufacturers Introduction

This template sets out the main headings of a development report that together would set out some of the required data that a toll manufacturer would like to have in order to assess the appropriateness of its own facilities and estimate the fees/costs that may arise from a toll operation. It is not intended to be exhaustive, and it will be necessary for discussions to be held with the prospective manufacturer before the toll contract can be finalised and the manufacturing operation started.

Main Headings

1. **Introduction/Background:** This would set out the key reasons for the toll manufacturing project to be considered. It would include the basic rationale behind the need for manufacture (What is to be manufactured? Why? Is it a completely new product? Are there any other reasons for the operation apart from the need for the product, eg to achieve a scale and quality from which a case for regulatory approval could be made? How much product will be manufactured? Who has been doing the manufacturing development work and whom can the prospective manufacturer(s) rely upon for advices? Are there any OHS concerns?)

   Normally the compilation of this section would be entirely the responsibility of the commercialization manager who would have the overview of this part of the commercialization strategy.

2. **Project Scope:** This section *briefly* describes the work that the toll manufacturer would have to accomplish, viz:

   - What is to be done? (eg manufacture of Product X at Y scale arriving at Z kg or tonne over A months…)
   - What is the process to be used? (eg the process as developed by R as described in the next section etc)
   - What are the secondary aims? (eg (i) to optimize the use of raw

materials or to minimize effluent; (ii) to scale up the process from X to Z scale; (iii) to determine and resolve OH & S issues; and (iv) to prove that the product(s) can be made in certain forms (concentrates, pure solids etc) etc)

3. **Process and Product Description**

This is arguably the most important section and it must be compiled essentially by the developer of the process, eg the R & D contractors.

Technically, this section would have all the hallmarks of a chemical engineering project with the following details:

- A detailed description of the process – ie a "blow-by-blow" "stage-by stage" description with all operating conditions at each stage. This description should be accompanied by a "box" diagram showing the key unit operations and their order of duties in the process;
- A process flowsheet which be based on the largest possible scale that the developer has worked on. Based on this, the flowsheet would preferably be drawn to show conditions and compositions of streams, mass and energy balances as needed and control points and equipment. While it is NOT expected that this flowsheet would meet the Australian standards for an P & I diagram, it should be aligned as closely as possible to these standards with appropriate symbols
- A separate/stand-alone mass and energy balance
- A clear statement outlining the form and quality of the final product
- A detailed specification/characterization of any effluent that is known to be generated from the process and the methods and standards of treatment (if known)

4. List of Equipment

This list should identify as completed as possible each unit operation and how a given unit operation should be carried out in what kind of equipment. For example, when evaporation is involved, the operation should be preferably defined in terms of the allowable rate of evaporation, allowable maximum temperature, what kind of evaporator (simple, double effect,

heated by steam or electricity…) would be most suitable, how the condensate and residual liquid are to be handled, at what point (temperature, concentration…) that the operation is deemed to be completed…

Often the developer, using laboratory equipment, is not in a position to provide the specifications of the "real-life" equipment that the toll manufacturer would have in its facilities or needs to build/install/modify to carry out the duty. In these instances, the description of the unit operations and how they may fit together by the developer may be of great use. For example, it may be possible to carry out all unit operations, from polymerisation to batch distillation with the condensation of the solvent leading to a concentrated solution (in the same solvent) of the product, in one single vessel with mixing, cooling and heating facilities. This revelation would greatly simplify the work of the toll manufacturer and significantly reduce the cost of the operation.

5. MSDS & Handling Issues – Raw Materials and Products

MSDS stands for "Material Safety Data Sheet" – a standard item that is issued by the supplier/seller of any given chemical. It gives, among other details:

- Detailed characteristics of the substance from its chemical formula, common and international name to quality (purity, appearance, forms, melting and freezing temperatures, ignition temperature, auto ignition characteristics as appropriate, density and specific gravity including those of the liquid or vapour forms,
  porosity, particle size, taste and smell (if appropriate), packaging forms and sizes;
- Its class – in accordance to the Dangerous Goods Act, and its UN Hazard Classification;
- Its toxicity as tested against the criteria appropriate to its class, appearance and form as stipulated in (for example) Australian NICNAS legislation;
- Its handling characteristics and consequential hazards (ingestion, irritations, possible dust and vapor explosions, spillage, and decomposition;
- Its compatibility with other materials, including materials of consturuction

- Its supply and storage requirements including any specific needs in size, shape and ventilation of the storage vessel or store, bunding, separation distances from other materials; and
- All of the above as applied to any by-products resulting from its uses or decomposition.

In the case of a new product that is still being allowed to be manufactured in small quantities (for example for commercial evaluation purposes) and has not yet gone through the full registration process, it is possible that few of the abovementioned data would be available. However, the developer/commercialiser should use their best endeavors to provide as many details as possible

6. SH & E/OH & S Considerations

During the negotiation for the toll manufacturing contract, both parties (developer-commercialiser and toll manufacturer) must agree upon the scale of operation (production rate per batch or per day). The toll manufacturer then has to come up with a process description at that scale. This is needed for the implementation of the project, starting with the performance of the HAZOP study.

One of the primary requirements of the contract is that the toll manufacturer must put its facilities destined for the duties through a full HAZOP (Hazard and Operability) process. This process, consisting of 6 stages, would identify all the hazards associated with the operation from the conceptual through design, installation, commissioning and normal operation of the facilities. NO CONTRACT SHOULD BE AWARDED UNTIL ALL SH & E/OH & S ISSUES AT LEAST AT HAZOP STAGE III HAVE BEEN RESOLVED TO BOTH PARTIES' SATISFACTION.

If during the operation of the equipment, modifications to them or to the way they should be operated, such modifications should also be subject to an HAZOP study.

To assist the toll manufacturer with the HAZOP process, the developer/commercialiser should provide all the SH & E/OH & S information that is known about the process and product. This may be for example as little as the need to use appropriate lubricants for seals and joints in the equipment.