TNO report
99.OR.VM.025.1/JV

TNO Automotive

5th DME Workshop; Dimethyl Ether as an Automotive Fuel
24 – 26 March 1999, Graz, Austria
IEA / AMF Annex XIV

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Netherlands Organization for Applied Scientific Research (TNO)

Contents

1 Introduction

This is the report of the fifth workshop on "DiMethyl-Ether (DME) as an automotive fuel" organised on 24-26 March 1999.

A total of 5 workshops are planned. During this fifth workshop the possibility of an extra workshop has been discussed. Except for the first, all workshops are held in the context of Annex XIV of IEA/AMF (International Energy Agency; Implementing Agreement "Alternative Motor Fuels"). The Dutch NOVEM and IEA/AMF jointly sponsored the first one.

The objective of Annex XIV is the investigation of subjects that are of general importance for the introduction of DME as an automotive fuel. The subjects focussed on establishing a fuel quality standard and obtaining information on environmental and safety aspects.

Previous workshops:

- November 1996, TNO Delft, The Netherlands;
- June 1997, TNO Delft, The Netherlands;
- February 1998, Amoco Corporation Naperville, Illinois, USA;
- October 1998, TNO Delft, The Netherlands.

Where the first two workshops mainly addressed organisational issues, the third and fourth workshop focussed on the various tasks as well as the exchange of information. This fifth workshop addressed the following issues:

- Reporting of the results of the various tasks;
- Finalising the tasks that were not yet ready;
- Discussing the future of DME as an automotive fuel and the role of this group in the future;
- Exchanging information.

In addition to the group that attended the workshops so far, for this fifth workshop representatives of several companies dealing with "fuel injection system components" and "elastomers" were invited.

This 5th workshop was kindly hosted by AVL List in Graz (Austria).

The original agenda of the workshop is included in Appendix A. The presentations of Mr. Verbeek, Mr. Sorenson and Mr.van Doorn were not given in order to have sufficient time for discussions about the future.

All participants are listed in Appendix B.

2 Progress of the Annex / IEA matters

An overview of all participating countries and companies can be found in appendix C.

An overview of the budgets per task can be found in appendix D.

At the last workshop a proposal concerning the dissemination of information has been discussed. TNO discussed this proposal with the IEA and adapted it with respect to their comments. The conclusions can be found in appendix E. The differences compared to the previous version are printed in Italics. In summary they are:

- The reports produced for this Annex are available to not directly involved companies of participating countries after 1.5 years.

- Companies appointed by government to carry out DME R&D projects can get the reports without delay.

Mr. van Doorn of TNO will take over the IEA activities from Ruud Verbeek. The reason is that Mr. Verbeek has currently too many tasks. Mr. van Doorn has been involved in several activities with DME, including the global assessment report. Mr. van Doorn is also an expert in LPG.

3 Progress on the tasks

The annex is split up in seven main tasks:

1. Trade-of fuel quality versus costs

2. Safety investigation (both distribution and application in vehicles)

3. Design guidelines

4. DME from renewable feedstock

5. Life Cycle Analysis

6. Costs of DME infrastructure

7. Operating agent / workshops / newsletter

Since the last workshop almost all tasks have made good progress. In the next paragraphs you will find a more detailed description of the progress per task and the results of the discussions during the workshop.

3.1 Trade-of fuel quality versus costs (Haldor Topsøe)

This investigation has come up with a proposed fuel specification for DME. This specification is displayed in appendix F.

Based on a 5000 tons per year production facility the total investment costs will increase 1% in order to obtain this specification, when compared to 98% pure DME. Haldor Topsøe states that this will result in a 0.75% increase in fuel price.

The fuel specification as proposed is accepted by the workshop as a target specification. At this time there is no reason to deviate from this specification. As soon as somebody comes up with a good reason to deviate from this specification this will be discussed.

During the workshop values for an odorant (ethylmercaptane) and a lubricant (Lubrizol, Hitech) were suggested. Table 1 shows the final fuel specification.

Table 1: Automotive fuel specification for DME

Impurity	Recommended value
Water	<0.01 [% w/w]
Methanol	<0.05 [% w/w]
Methyl Ethyl Ether	<0.20 [% w/w]
Higher Alcohols	<0.05 [% w/w]
Higher Ethers	<0.05 [% w/w]
Ketones	<0.05 [% w/w]
Odorant (ethylmercaptane)	20 [ppm]
Lubricant (Lubrizol or Hitec)	500 – 2000 [ppm]

3.2 Safety investigation (TNO)

Four reports are ready; these reports are distributed to all participants and delegates:

1. Failure Mode and Effect Analysis DME vehicle storage tank systems (TNO-MEP - R 98/449)

2. Toxicity aspects of dimethylether in comparison with automotive fuels currently in use (TNO-MEP - R 99/015)

3. Proposal for safety guidelines for DME fuelling systems and their installation in vehicles (TNO 98.OR.VM.051.1/JV)

4. Conversion of LPG distribution guidelines into DME distribution guidelines (TNO-MEP - R 99/050)

Main conclusions of this task are:

- The LPG regulations considered for this investigation will hold for DME as well;

- Material compatibility is essential for safety;

- DME brings no additional safety issues when comparable safety provisions as for LPG are taken and suitable materials are used. In places where both LPG and DME need to be handled, mixing up the two fuels should be prevented, e.g. by providing different connections.

During the workshop it was suggested that before these safety reports are used as a bases for governmental legislation, the issue of material compatibility should be given concrete form to.

In order to ensure proper separation of DME and LPG it is suggested to mark components for DME and to design and adopt a special DME filler unit.

In addition to the original safety task a small desk study has been carried out into the toxicity aspects of DME in comparison with other automotive fuels. The sheets presented at the workshop concerning this topic are easily misinterpreted and should therefore be discarded. The title of the report should have emphasised that the study focused on one case only; the accidental release of DME during the unloading of a DME distribution truck at a refuelling station. The conclusion of the report however remains strait forward: for the case studied, toxicity is not an issue for DME as automotive fuel, even with up to 20% methanol content.

At the workshop a small discussion addressed the issue of parking houses and the possible 'block' for DME when vehicles running on DME are excluded from these parking houses. At this point these is no reason to assume that this will be the case.

Just too late for the workshop , Gary Webster faxed some remarks of Du Pont on the distribution guidelines. Although they are not discussed at the workshop, the remarks are included as appendix I

3.3 Design guidelines (AVL)

The work for this task is done; the report is ready:

"Design guidelines for DiMethyl Ether injection systems" (AVL report BE 0472, March 1999).

Copies of the report are distributed at the workshop; feedback is appreciated. Some general conclusions are drawn in co-operation with task 2. Important issue is injector leakage and consequently the need to purge part of the injection system after shut down of the engine. Furthermore the temperature dependence of many DME properties is emphasised as a point of attention for the design of DME injection equipment.

3.4 DME from renewable feedstock (Atrax Energi AB)

The final report for this task is almost ready. Area of attention is the gasification part of the process. Atrax thinks it can be developed in 3 to 4 years.

3.5 Life Cycle Analysis (Innas)

In this study the complete well to wheel fuel chain of various fuels is evaluated and compared to each other based on existing data (no new measurements are carried out). During the workshop it was suggested to eliminate the extreme (not-realistic) values. For some items the data range is too large. A draft report has been discussed at the workshop; the final report is expected to be ready in May 1999.

3.6 Costs of DME infrastructure (Innas)

In this task, the investment costs to set up a DME distribution infrastructure and the operating costs of such an infrastructure are estimated. Because DME is not used as an automotive fuel yet and because handling of DME is similar to handling LPG, figures from LPG distribution are used as a basis. The costs for different stages of the distribution are estimated separately. These stages are sea transport, unloading and storage at a harbour, transportation by road, rail or pipeline, intermediate storage and finally dispensing at a refuelling station. A distribution scenario will be used as an example to calculate total DME distribution costs. During the workshop, a first raw draft report was discussed between the participating parties. The final report is scheduled for this summer.

3.7 Newsletter (TNO)

The second newsletter has been issued in December last year. The third newsletter is planned for this spring. The newsletter will address the progress of the various tasks in the annex. All task leaders will provide a short article on their task. Next an update will be given for developments mentioned in the previous newsletters.

4 Presentations

4.1 DuPont Dow elastomers, Oliver Franssen

Mr. Franssen introduces his company and a product that is very suitable for DME-applications; Kalrez. This product has high resistance against heat as well as oil due to the lack of Hydrogen to Carbon bonds. As a general rule of thumb one can say that any product that can be made of rubber can also be made of Kalrez. At this time Kalrez is relatively expensive, when numbers increase it should come down in price significantly. Dupont Dow will be glad to support future tests with material and information. Important for the seals is the influence of impurities, lubricants, odorants et cetera. Therefore it is necessary to define a DME specification including these items for elastomer testing. Next a comparative test programme on EPDM and Kalrez can be carried out. Dupont Dow thinks that EPDM in the proper composition is a good material for test-engines, not for production. A test programme should include dimensional stability, temperature resistance, property change and permeability tests.

4.2 Volvo, Henrik Landälv

For Volvo it is of great importance that alternative fuels like DME address the issue of CO_2. Right now we need arguments that DME addresses this issue.

At this time one DME-bus is running at Volvo's own premises as a demo/test vehicle. The actual demonstration in Denmark is postponed.

Volvo is in principle positive to further develop DME vehicles, but only if risks are shared with other car manufacturers, automotive supply industry, fuel supply industry and governments.

One of the arguments that came up during the discussions: DME can be made from associated gas that is now flared. Through preventing this gas from being flared and using the energy usefully, a CO_2 reduction is realised.

4.3 Energy Scenarios, Ruud Verbeek (TNO)

TNO presented 2 sheets with fuel options for the future. The contents of the sheets including the input from the workshop participants is presented in Table 2 and 3. Table 2 is for the medium term future, where more fuels will be based on natural gas. Table 3 is for long term future, where fuels will be renewable.

DME and methanol are the two fuels, which are suitable for both medium and long term future; i.e. in a transition period they will be made from natural gas and on the long term from renewable feedstock. By making DME or methanol from industrial waste (wood and plastic) worldwide CO_2 emission can be reduced.

Advantage of DME over methanol (Otto cycle) is the higher overall efficiency leading to lower overall CO_2 emission. Disadvantage of DME is that the fuel injection system needs much more development work.

For India Amoco is studying the possibilities of using DME for electricity production. In this case natural gas from nearby countries is converted into DME and then transported to India, where it is used for electricity production. One of the alternatives, LNG, requires massive port development and regasification facilities. Therefore LNG is most suitable when the fuel demand is concentrated, and the total power plant capacity is greater than 2000 MW.

Once DME is used for power generation, the quantities are so large, that DME can also be made available economically for transportation.

Table 2: Fuels from Natural gas

Fuel	**Remarks / characteristics**
CNG	Large and heavy tanks Expensive filling stations (fast fill)
LNG	Storage losses cryogenic tanks Expensive infrastructure
DME	Needs infrastructure (like LPG) Needs fuel system development Tank is larger than diesel fuel tank Elastomers problem can be solved DME also suitable for fuel cell
Methanol	Low overall efficiency Toxicity Also fuel cell fuel
Synthetic diesel fuel (Fischer Tropsch, SMDP)	Lower overall efficiency than DME (higher CO2 than DME) Requires particul. trap for EURO-4 / EURO-5 emissions Cold flow properties neat fuel are poor Investment costs plant +20% compared to DME Suitable for blend with diesel fuel

Table 3: Renewable fuels / fuels from waste:

Fuel	Feedstock / remarks
Bio-ethanol	Sugar, wheat, wood Normally as blend with gasoline Needs cetane improver for diesel cycle
Bio-DEE	Sugar, wheat, wood Lower energy efficiency than DME
Bio-DME	Wood, waste Needs infrastructure
Bio-gas	Sustainable solution for bio-waste, manure, sludge Large and heavy tanks, needs expensive infrastructure Suitable for stationary engines
Vegetable oil esters	Rapeseed oil, etc. Limited supply feedstock
Bio-methanol	Wood, waste

4.4 Robert Bosch GmbH, Bernd Mahr

Concerning the application of DME in Diesel engines, Bosch states: (see also appendix G).

- DME could become one of the future alternative fuels for diesel engines.
- There will be no development started at Bosch based on the state of the art of DME fuel injection system.
- Very complex systems; for DME necessary high effort of advanced development, serial development and manufacturing.
- Bosch offers to support the investigations at AVL providing a modified A-pump.
- Decision about further Bosch activities on DME in the beginning of 2000.

Next to this, Bosch thinks that at this time the best alternative for diesel fuel is improved diesel fuel.

Durability necessary for heavy-duty application is some 20.000 hours.

New input to support the decision in the beginning of the year 2000 is the result from AVL as well as the development in India (power generation with DME).

4.5 NKK DME truck, Harald Torgard & Knut Skardalsmo (Statoil)

Harald visited NKK and actually drove in the truck. Harald obtained some sheets, which he presented. NKK themselves converted the 3.6 l diesel engine into a DME engine by relatively small modification. The engine uses an in-line type DME injection pump similar to the diesel fuel pump. Possible leaked DME is ventilated to the inlet system of the engine. The DME tank is additionally pressurised with helium. The engine showed no black smoke and the NO_x emission is reduced by 25%.

4.6 European project, Pierre Lacome (Renault)

Renault presents the status of a DME demo project, to be funded by the European Union within the fifth framework. Next to Renault, IFP, PSA and TNO will participate. In order to speed up the process as well as to reduce the costs, more partners are needed. At the workshop AVL, Volvo, Statoil, Haldor Topsøe, BP/Amoco and Vialle showed their interest in participating in this project.

The project starts in 2000 and will take approximately 3 years. At that point demonstration vehicles should be running. If at that time the decision is taken to further develop this technology towards a production vehicle, Renault thinks that another 2 to 3 years are necessary for finalising the design and again 2 to 3 years to develop the necessary parts for series production.

Appendix H shows the slides of this presentation.

5 Conclusions and continuation

DME projects:

- TNO will try to get support for continuation of activities for IEA/AMF:
  - Workshops / newsletters
  - Investigation of durability of DME injection system components and elastomers.
- EU project(s):
  A large EU project is essential for the development of the DME engine. A possibility is the Renault/TNO program. AVL and Haldor Topsoe would like to participate in such a program. Preferably there should be 1 car and 1 truck/bus program.

Communication:

Objective is to bring DME more under the attention of OEM's, component manufacturers, government (and EU) officials and publishers.

Actions:

- A more widespread distribution of the newsletter: make use of AVL and TNO address databases. TNO will send newsletters to AVL.
- Investigate possibility to organise a demo/mini-symposium around the Volvo bus (to interest OEM's and others).
- Report/publication of Volvo bus (preferably including chassis dyno test in Denmark).

Energy scenarios:

The fuel with the lowest overall CO2 emission should be promoted. DME is an excellent candidate among others due to diesel cycle efficiency:

- Medium term: DME from natural gas: usage of remotely available natural gas and associated gas.
- Long term: DME from wood and waste.

If the use of DME for power generations brakes through, it can also be made available economically for (demonstration programs for) vehicle use.

Involvement of automotive supply industry (which participated in this workshop):

- Dupont-Dow is the opinion that cost effective elastomer solutions can be developed for DME fuel system. They are willing to do some R&D on this.
- Bosch will postpone a decision about DME fuel system development until next year.
- Warner International is working on new pump concept, which could become available for DME in several years.

Workshop /meetings:

- Next workshop: 4 and 5 November 1999 (in Delft or possibly Sweden).
- Optionally: extra meeting in August or so (smaller group).

Appendix A Agenda DME Workshop: 24-26 March 1999, Graz, Austria

Wednesday:

13:00 Sandwiches / coffee

13:30 Opening / Agenda

13:45 IEA project / Progress

14:15 Presentation progress 6 tasks of IEA/AMF project
Fuel quality, Safety, Design guidelines, DME from renewable feedstock, Life cycle analysis, Costs of DME infrastructure, Newsletter.

17:30 End of session

Informal dinner: sponsored by AVL

Thursday:

8:30 Presentations (a.o. DME R&D projects):
Oliver Franssen (Dupont): Dupont products
Option: Ruud Verbeek: Global assessment of DME
Spencer Sorenson: Wear and additives with DME in diesel systems
Anton van Doorn: Ford 2.5 l engine with shuttle valve
DME injection system

13:00 Discussion follow up of IEA project

14:30 Discussion in task groups:
Current tasks and/or follow up project

16:15 Conclusions task groups

17:00:DME newsletter

Friday:

8:30 Conclusions / actions

9:00 Departure for visit AVL

Appendix B Participants

DME Workshop participants

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V= present, X= not present

Appendix C Participating countries

Austria	AVL-List
Canada:	AET and NR Canada
Denmark:	Haldor Topsøe A/S Technical University of Denmark
	–
Finland	Renault, PSA and IFP
France	
	–
Japan	
Netherlands	Innas BV TNO Automotive
Norway	Statoil
Sweden	Atrax Energi AB Volvo Truck
USA	Amoco Corporation AVL Powertrain Engineering

Appendix D Budgets per task

TASK	approx. budget (k-USD)
1. Fuel quality	60
2. Safety	
Europe	90
North America	100
3. Design guidelines	42
4. Bio-DME	140
5. Life cycle analysis	185
6. Costs infrastructure	40
7. Operating agent Workshops Info cent./newsletter	130
Total	787

Appendix E Dissemination of information

Newsletter:

– Hardcopy to companies and government representatives involved in Annex XIV

– Internet: Unrestricted

Workshop and Task reports:

Participating countries Annex XIV:

– Government representatives

– Companies participating in tasks

– *Companies appointed by government to carry out DME R&D projects*

– Any company which requests them after a period of *1.5 years* (at printing/handling costs).

Sponsors:

– Companies from these countries with approval from sponsor after a period of *1.5 years* (at printing/handling costs).

Reports task 2 and task 3; safety & design guidelines:

Unrestricted

Publications:

– co-author or acknowledge parties that supplied information

– acknowledge IEA/AMF and sponsors

Appendix F Automotive Fuel Specifications for DME

Automotive Fuel Specifications for DME
Impurities in Weight %

	Minimum Suggestions	Recommended value
Water	< 0.005	< 0.01
Methanol	< 0.005	< 0.05
Methyl Ethyl Ether	< 0.100	< 0.20
Higher Alcohols	< 0.001	< 0.05
Higher Ethers	< 0.001	< 0.05
Ketones	< 0.001	< 0.05

Appendix G Statement Robbert Bosch

Application of DME in Diesel Engines
Statement RB (03.99)

- DME could become one of the future alternative fuels for diesel engines.
- There will be no development startet at RB based on the state of the art of DME fuel injection system.
- Very complex system; for DME necessary high effort of advanced development, serial development and manufacturing.
- RB offers to support the investigations at AVL providing a modified A-pump.
- Decision about further Bosch activities on DME in the beginning of 2000.

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Appendix H European Demo Project

FA DIESE

Fuel Alternatives for Diesel

Position of the Problem:

The ACEA commitment : 140 g CO_2 in 2 008 needs :

- Light weight vehicles
- Gas. Direct Injection
- Hybrid vehicles
- ***Diesel engines***
- Fuel Cells

Diesel technology will comply with EURO IV (2 005) regulations.

More drastic regulations could need SYNTHESIS ALTERNATIVE FUELS

- Aquazole
- Gas-to Liquid (F.T.) synthesis diesel
- Methanol-diesel mixture
- Di Methoxy Methane
- D. M.E.

FA DIESE

Fuel Alternatives for Diesel

Objectives :

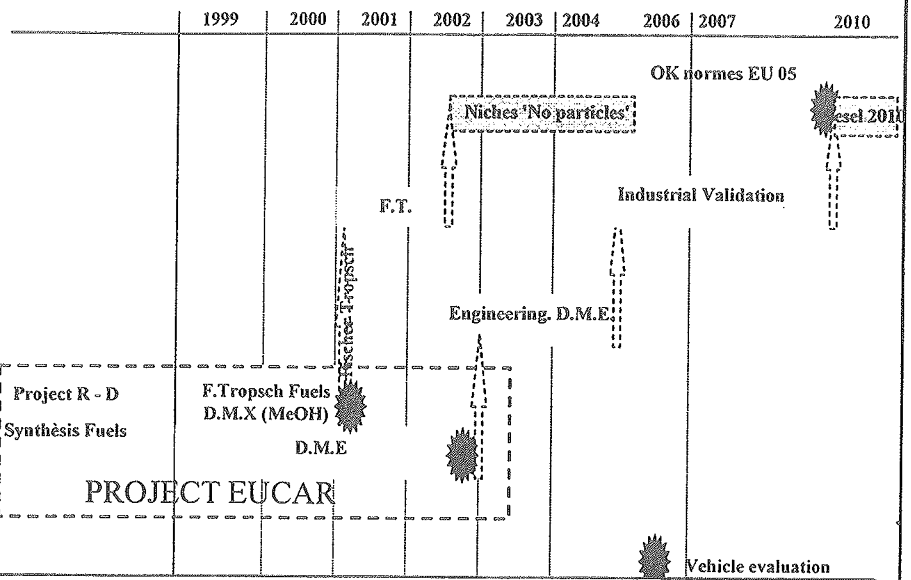
- CONTRIBUTE to : CO_2 140 g/ km in 2 008 (ACEA)
- PRESERVE ACCEPTABILITY of DIESEL after 2005
- Through SYNTHESIS ALTERNATIVE FUELS (2005 - 2010 ...)
- In a COMMON STRATEGY via EUCAR / IEA

- Investigating the FLEXIBILITY of a COMMON FUEL for :
  - DIESEL engines
  - FUEL CELL REFORMERS
  - DOMESTIC USE

RENAULT Research P.Lacome J.C. Griesemann EUCAR Meeting Brussels 24th February 99

FA DIESE

Fuel Alternatives for Diesel



FA DIESE

Fuel Alternatives for Diesel

CONTENT of the PROJECT:

SYNTHESIS ALTERNATIVE FUELS

	Aquazole	D.M.X.	G.T.L.	D.M.E.
- GLOBAL Balance incl. economics	X	X	X	X
- Create injection system.				X
- Tuning injection system				X
- Engine calibrating			X	X
- Emissions tests	X	X	X	X

FA DIESE

Fuel Alternatives for Diesel

Present Partners:

RENAULT PEUGEOT P.S.A. VOLVO ?
T.N.O. (NL) I.F.P.(F)

OPEN to :

EUCAR manufacturers
Injection Syst. suppliers (CLEPA)
IEA Members

DURATION : 3 years (2 000 - 2 003)

FA DIESE

Fuel Alternatives for Diesel

Background :

Engine pre-evaluations : (AVL, SHELL, Air Products)	particles reduced by 25% (GTL) to 100% (DME) NOx reduced by 10% GTL) to 66 % (DME) CO2 reduced by 9 % (DME)
Materials compatibility:	operational solutions found (RENAULT, VOLVO)
Injection Systems :	operational solutions tested (RENAULT, VOLVO)
Vehicular tests :	Delivery van (DME) driven (NKK, Japan) Experimental bus (DME) to be tested (VOLVO)

OBJECT of the PROJECT

WHO DOES WHAT ?
(2 engines / vehicles)

Preliminary fuel validation (home made FIS / engine) : Renault - PSA
Global balance study (Fuels) : IFP (F), IEA/AMF (Annex XIV)

Injection system :

•Specifications :	Renault - TNO
•Material compatibility :	Renault (LJF)
•System design :	Partner Supplier
•Components validation tests :	TNO - Renault
•Spray combustion visualisation :	Renault
•Injection rate shape characterisation :	TNO

Engines

•Engine tunning :	IFP (Renault Engine)
	TNO (PSA Engine)

Vehicles

•Vehicle fine calibration	Renault - PSA

Appendix I Du Pont remarks on distribution guidelines

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DUPONT

DuPont Specialty Chemicals

Dear Mr. Gary Webster, March 23, 1999

Following are the highlights of my review of the DME Distribution Guidelines Manual. Thank you for the opportunity to review and commnet on it.

Dimethyl ether can react with oxygen to produce dimethyl peroxide under the right conditions. Dimethyl peroxide will form crystals and precipitate out of the DME over time. This could be a major concern because the dimethyl peroxide crystals are known to be shock sensitive. This is a well known concern with ethyl ether, and can result in explosions.

DuPont has not had any problems with dimethyl peroxide formation in Dimethyl Ether over the past 60 years because the DME does not contact oxygen and very rapid and complete turnover of DME inventory. The DME process and storage tanks/shipping vessels are purged of oxygen with nitrogen prior to the introduction of DME following maintenance. DuPont recommends that the DME distribution guidelines mention the need of removing the oxygen atmosphere prior to the introduction of DME to prevent dimethyl peroxide formation.

Following is a brief summary of the changes I suggest for the manual written by TNO:

1. All references to use of a dry power fire extinguisher for DME fires are incorrect. A CO2 fire extinguisher is the preferred choice for fighting gas fires. Dry powder extinguishers are the preferred choice for solid or liquid fires, but are unacceptable for gas fires. Be aware that although the fire may go out once extinguished, if the DME leak continues, the fire may ignite again. Request back-up at the first sign of a DME fire because the fire burns hot and quick.
2. DME unloading vent stacks to the atmosphere or on DME storage tanks should be equipped with a flame arrestor. The difference in static charge between the process equipment and a passing thunderstorm will ignite DME vapors being emitted from the vent stack, which could possibly propagate back through the vent piping to the tank truck or tank.
3. Grounding of DME storage tanks and DME tank trucks is very important to prevent generating static charge that can result in a DME flash fire. DuPont had the electrical conductivity of DME measured by a specialist who determined that DME is conductive in the liquid phase under some conditions, but can be non-conductive in the vapor phase. DME flowing through nonconducting material such as teflon lined hoses and plastic drain tubing can generate significant static charge, enough to spark and generate a flash fire.
4. Maintenance to DME equipment should only be done with non-sparking tools such as copper or bronze wrenches when making the "first -break" into lines for maintenance, unless the equipment has been swept with nitrogen first, has no pressure, and is confirmed empty. A spark from a steel tool could ignite an unseen DME leak and burn personnel.
5. References to DME leaks as a visible "white cloud" is incorrect. Only very large DME leaks will form white vapor clouds from the DME subcooling water vapor in the air and causing it to condense. Smaller DME leaks will NOT be readily visible to the naked eye and can be very difficult to detect since pure DME has minimal odor. A DME leak large enough to render an operator or mechanic unconscious could occur without any significant indications by sight or odor. Therefore it is recommended that personnel use a meter to detect both oxygen content and LEL whenever maintenance work is planned or in progress, or a DME leak is suspected.
6. The DuPont 8-hour AEL is 1000 ppm for DME. Exposure levels above this concentration will result in severe irritations to the throat and nasal passages. Exposures significantly above these

levels could result in lethargic action and slower mental reactions prior to unconsciousness.

7. DME leaks that have ignited are very difficult to see because unlike LPG which burns yellow, the DME flame burns a faint blue flame. During the daylight, a DME fire may go undetected because the DME burns cleanly and there is no smoke. Flame retardant clothing is recommended for people who load, transport and unload or enter an area where DME is handled. Prevention is the best course of action, by conducting thorough leak tests using either 80-100 psig nitrogen with an ultrasonic detector, or Helium with a mass detector after all routine maintenance to DME equipment, prior to returning the equipment to DME service.
8. Note: standard NPT threaded connections are not adequate to prevent DME leaks, and DuPont recommends all storage tanks, fixed equipment and piping use only butt-welded ANSI flanges. DuPont DME storage tanks vessel walls are rated for 150 psig minimum, and stress relieved for temperatures down to -40 F. DME vessel flanges should be rated for 300 psig and have schedule 160 nozzles to provide adequate compression forces to seal non-flammable gaskets leak tight, especially manway nozzles and vessel nozzles greater than 8 inches in diameter. The flange surface flatness (tilt and waveness) must be <0.005 inches. Flange torquing requirements must be specificed for the particular gasket chosen to ensure the equipment is free of leaks.
9. DuPont recommends using sealed level device technology. Use a magnetic slip gauge rods in transportation vessels, and weigh scales to confirm shipment weights. The Best Available Technology (BAT) for DME storage tank level devices is a conductivity probe, which must have an integral temperature compensation device because the conductivity of DME changes significantly over the normal ambient temperature range of DME.
10. DME compatible elastomers are difficult to find. DuPont has had excellent results in DME service using DuPont Kalrez elastomer. DuPont DME shipping vessels have had no leaks over the past 17 years while using DuPont Kalrez elastomers in the DME RVs. DuPont Kalrez is used in all DuPont DME transport vessel RVs and DME process RVs. Not all tank truck relief valve (RV) designs perform equally well in DME service with Kalrez, and DuPont recommends one particular RV manufacturer who has an RV design that has proven superior with DuPont Kalrez in DME tank truck service since 1990. The DuPont Kalrez elastomer in the relief valves is replaced on a routine preventative maintenance schedule every five years for tank trucks and every ten years for rail cars. The DuPont Kalrez elastomer formulation recipe and processing conditions dictate the chemical resistance and physical properties of the Kalrez elastomer. A commercially available non-DuPont Kalrez-like elastomer has had unacceptable inferior performance in DME service.
11. DuPont recommends using transfer hoses that have a core of convoluted stainless steel with a stainless steel overbraid and a burst pressure of 1700 psig. The preferred DME hose coupling is the Fisher M-130 female coupling backwelded to the hose ends. DME hoses are hydrostatically tested every two years at 250 PSIG pressure.
12. DuPont has experience with cartridge filters in DME service. It is recommended that a metal 304 or 316 stainless steel core be selected. Either a wound cotton or wound glass element is recommended in DME service with the capability to remove particles <1 micron.

Sincerely, Phillip W. Twaddle

Phillip W. Twaddle

DuPont DME Technical Engineer