NATO STANDARD

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DESIGN AND PERFORMANCE REQUIREMENTS FOR ADDITIVE INJECTION EQUIPMENT FOR MILITARY FUELS

Edition A Version 2

December 2014

NORTH ATLANTIC TREATY ORGANIZATION

ALLIED FUELS AND LUBRICANTS PUBLICATION

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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

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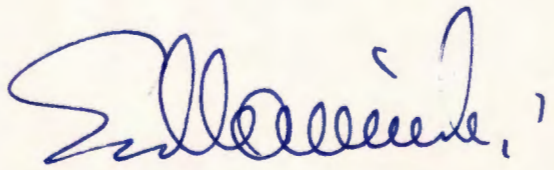
NATO LETTER OF PROMULGATION

2 December 2014

1. The enclosed Allied Fuels and Lubricants Publication AFLP-7071, Edition A Version 2, DESIGN AND PERFORMANCE REQUIREMENTS FOR ADDITIVE INJECTION EQUIPMENTFOR MILITARY FUELS which has been approved by the nations in the AC/112, is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 7071.

2. AFLP-7071, Edition A, Version 2, is effective upon receipt.

4. This publication shall be handled in accordance with C-M(2002)60.



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Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS
Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Documents Database for the complete list of existing reservations.	

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RECORD OF SPECIFIC RESERVATIONS

[nation]	[detail of reservation]
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SECTION 1 INTRODUCTION

0101. NATO Forces must be able to supply and/or receive kerosene-based fuels from each other.

0102. These fuels shall meet the guide specification STANAG 3747 and meet the deterioration limits of STANAG 1110.

0103. In order to ensure that the fuel meets these requirements it is necessary to have the capability to inject approved fuel additives into the system prior to delivery.

0104. The requirements set out in this STANAG represent the minimum capability for injection equipment to meet the agreed needs.

0105. Future equipment procured by nations will meet the requirements of this STANAG and enable injection of the additives into kerosene based fuel for Aviation purposes as detailed in Sections 2-4.

0106. Future equipment procured by nations will meet the requirements of this STANAG and enable injection of the additives into kerosene based fuel for ground purposes as detailed in Sections, 2, 3 and 5.

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SECTION 2 ADDITIVE INJECTION EQUIPMENT PERFORMANCE CRITERIA

General Characteristics

0201. This Section covers the performance requirements for additive injection equipment for both fixed and tactical fuel handling operations. Additional requirements for Tactical Fuel Handling Equipment (TFHE) are specified in Section 3. The additives required for injection into aviation and ground fuels are given at Section 4 and Section 5 respectively. Section 6 contains a conversion chart summarizing the additive requirements for aviation and ground fuels.

0202. The equipment shall be capable of injecting additives into fuel distribution systems under dynamic flow conditions. The injection equipment is to be capable of injecting single or multiple additives simultaneously whilst maintaining segregation of the additives.

Fuel Flow Rate

0203. The equipment shall be capable of injection rates proportionate to flow, effective over variable fuel flow rates and pressures. When fuel flow is initiated, injection begins. Conversely when flow slows or stops injection slows or stops proportionately, with no action necessary from the operator. The equipment will be used to inject additives into permanent and tactical distribution and storage installations, bulk fuel carrying vehicles, rail tank cars, inland water transport and directly at the skin of aircraft. The flow rates are role specific.

0204. The flow capability of the equipment for fixed installations should be designed for the site specific flow range. A typical flow rate for fixed installations is 2000 litres per minute.

0205. Tactical injection equipment should be designed to match the flow rates of the dispensing equipment. This will vary depending on the design of the installation and in particular where the additive is to be injected. If injection of the additive is carried out into the receipt line to the tank, flow rates similar to fixed installations e.g. 2000 litres per minute could be experienced. If injection is to be carried out into the dispense lines capable of refuelling aircraft or vehicles, flow rates of 680 litres per minute would be more typical.

Additive Injection Rates

0206. The equipment(s) shall be capable of injecting additives singly at the rates detailed at Section 4 for Aviation use and Section 5 for Ground use.

Design Operating Pressure

0207. The equipment shall have a design pressure appropriate to the application. Most low-pressure pipeline applications are between 3 and 10 bar for fixed installations.

0208. Pipelines. The mainline pump sets are generally rated at ANSI class 300. The injection point for the additive will be on the suction side of the mainline pumps or downstream of the Pressure Reducing Valve (PRV) to minimize the head required of the additive injector. Pressures at this point would typically be below 10 bar.

0209. Loading Facilities. Road and rail loading systems are typically ANSI class 150-pressure rating. The additive will normally be injected into the piping on the pressure side of the loading pump. Typical pressures at this point would be 3 to 8 bar depending on site conditions.

Operating Temperatures

0210. The equipment is to be capable of operating in accordance with NATO definitions for climatic conditions in STANAG 4370 AECTP 200 leaflet 2311/1 Edition 3 Annex A: Category A3 (+58^{o}C) to Category C 1 (-33^{o}C). See Annex C paragraph 3 for information on the low temperature viscosity requirements of S-1747.

Viscosity Requirements

0211. The additive injection equipment may be capable of injecting one or all of the additives included in this STANAG, at the dose and dilution ratios specified in Section 4 for Aviation purposes and Section 5 for Ground purposes. The equipment, including pumps, is to be capable of dispensing additives with a kinematic viscosity of up to 1000 mm^2/s.

Power Supply

0212. The equipment may be self powered i.e. the unit will take energy from the main fuel flow to drive the injection system. However where an alternative power source is used it must be suitable for the environment.

Equipment Accuracy

0213. The accuracy of additive injection into the main fuel stream shall be within $\pm$ 1% of the nominal dose rate of the additive.

Calibration Facility

0214. The equipment shall be provided with a means of calibrating the injection rate of each additive separately. As a minimum, a calibrated measuring glass, piped into

the unit so that the additive flow rate may be gauged over a period of time is required. This facility will be used to initially set up the dose rate and to carry out regular audit checks of the injection equipment performance.

Materials Compatibility

0215. All wetted components of the additive injection equipment must be resistant to and not contaminate any additives specified in this STANAG. Aluminium should be avoided where contact with S-1745 and S-1747 is likely. In addition zinc, lead, cadmium, copper or aluminium alloys containing more than 4% copper should also be avoided where they could come into contact with fuel.

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SECTION 3 AIR TRANSPORTABLE INJECTION EQUIPMENT

General

0301. Air Transportable Injection Equipment shall be capable of injecting aviation fuel additives into fuel dispensed from Battlefield and Forward Bulk Fuel Installations, hydrant systems and vehicles. The equipment may be either self contained or modularised, and preferably skid mounted with a spill containment system.

0302. The equipment shall also be suitable for use in the ground support equipment role for aircraft detachments to airfields were aviation fuel requires additives blended at the skin of the aircraft e.g. when Jet A-1 is issued from a hydrant system and needs conversion to F-34. In this role the equipment requires to be capable of operating on its own in support of air operations.

Performance Requirements

0303. The equipment shall meet all performance requirements of Section 2.

Connectors

0304. The equipment shall be capable of being connected to a variety of systems' hardware. As a minimum, the equipment shall be provided with the female half of the STANAG 3756 NATO coupler on the inlet side and the male half of the STANAG 3756 NATO coupler on the outlet side.

Weight

0305. The equipment shall be designed for Air Transportation and have suitable fixtures and fittings to allow movement by Mechanical Handling Equipment (MHE).

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SECTION 4 ADDITIVE INJECTION REQUIREMENTS FOR AVIATION FUEL

Aviation Fuel Additives

401. This Section covers the addition of additives to aviation fuel either to convert the product or to return it to on-specification. Injection of additives by NATO forces will be carried out to convert the base fuel to the required operational fuel or to bring a product within specification limits with respect to additive concentration. The amount of additives required to bring a product within specification will depend on the source of the fuel and the extent of the depletion of the additive in the fuel. The amount to be added is governed by the guide specifications STANAG 3747 and STANAG 1110. The injection equipment specified in this STANAG is to be suitable for full additive addition but pre-dilution of the additive may be necessary where the amount required is small. Mixing of additives prior to injection is not permitted.

Additive requirements for operational aviation fuels

402. Three additives, Static Dissipator Additive (SDA), Fuel System Icing Inhibitor (FSII) and Lubricity Improver (LI), are mandatory in F-34. SDA is also mandatory in F-35. Both FSII and LI are added to Aviation Turbine Fuel F-35 to convert it into F-34.

a. Fuel System Icing Inhibitor (FSII) NATO Code S-1745. Fuel System Icing Inhibitor is a low viscosity product and no problems for injection equipment are to be expected.

b. Lubricity Improver Additive (LI) NATO Code S-1747. The lubricity improver additive will be selected from one of the products approved in STANAG 3390. All of these products exhibit high viscosity at low temperatures. If necessary the additive may be pre-diluted such that the highest viscosity to be handled by the equipment is 1000 mm^2/s. (A dilution of 1:4 in F-35 will achieve the desired viscosity).

c. Static Dissipator Additive (SDA). SDA will normally be added at the refinery or by the supplier prior to delivery into the NATO Pipeline System (NPS) or to field locations. The treat rate of SDA to meet the conductivity requirement of F-34 is between 1 ppm and 5 ppm. Re-injection of SDA to maintain the conductivity of F-34 is controlled by STANAG 3747. Equipment to achieve the required accuracy at these low treat rates is very expensive and it is recommended that SDA be diluted with F-35 prior to injection. When the injection of SDA is required on an infrequent basis and the injection of other additives is not being accomplished at the same time, SDA may be injected using the LI injection head. In this case, the injection equipment flow rate needs to be adjusted, or the SDA dilution ratio adapted in order to obtain the prescribed dose ratio. A check of product conductivity should be performed after additive injection. Where regular injection of SDA is

required, or when additives other than SDA are being injected simultaneously, a separate dedicated injection head must be used. SDA is a low viscosity product and no problems for injection equipment are expected.

2.4 Thermal Stability Additive (TSA) S-1749. Thermal Stability Additive is a low viscosity product and no problems for injection equipment are to be expected.

Notes: 1. It is known to adversely affect the performance of some filter water separators (FWS) and therefore special attention must be given to the location of the injection equipment.
2. TSA will not normally be used on NATO operations.

Injection Ratio Adjustments

403. The equipment shall be capable of separate variable and continuous adjustment of each additive type at the injection point. The following table specifies the range adjustment required of each additive.

NATO CODE	PRODUCT DESCRIPTION	Required treat rate of additive in the final fuel blend (g/m^3)		Injector range adjustment (g/m^3)	
		MIN	MAX	MIN	MAX
S-1745	Fuel System Icing Inhibitor (FSII)	1000	1500	500	2000
S-1747	Lubricity Improver (LI)	9*	23	5	40
-	Static Dissipator Additive (SDA)	1	5	10 (pre-diluted 10:1)	50 (pre-diluted 10:1)
S-1749	Thermal Stability Additive (TSA)**	150	250	100	500

Note: * This is additive dependent, the minimum additive treat rate is specified in STANAG 3390 for each specific product.
** F-37 will not be used on deployed combined operations or as a NATO cross service fuel.

Performance Requirements

404. The equipment shall meet all performance requirements of Section 2 and, if air transportable, Section 3.

Fuel conversion charts

405. Conversion charts for aviation fuels are at following pages of this Section.

CONVERSION OF F-35 TO F-34

INPUT FUEL	ADDITIVES REQUIRED	TREAT RATE (g/m^3)	INJECTOR RANGE (g/m^3)	OUTPUT FUEL
F-35	S-1745	1000 – 1500	500 – 2000	F-34
	S-1747	9 – 23	5 – 40	

CONVERSION OF F-35 TO F-37

INPUT FUEL	ADDITIVES REQUIRED	TREAT RATE (g/m^3)	INJECTOR RANGE (g/m^3)	OUTPUT FUEL
F-35	S-1745	1000 – 1500	500 – 2000	F-37
	S-1747	8 – 22	5 - 40	
	S-1749	150 – 250	100 – 500	

CONVERSION OF F-35 (ADDITIVE DEPLETED) TO F-35

INPUT FUEL	ADDITIVES REQUIRED	TREAT RATE (g/m^3)	INJECTOR RANGE (g/m^3)	OUTPUT FUEL
F-35 (ADDITIVE DEPLETED)	SDA	1 – 5 *	10 – 50 **	F-35

* Only 5 g/m^3 maximum shall be added to a single batch of F-35 during its life. Before redosing the SDA the original treat rate and any subsequent additions should be established so that any further additions do not exceed 5 g/m^3.

** Pre-diluted at 10:1.

CONVERSION OF F-34 TO F-37

INPUT FUEL	ADDITIVES REQUIRED	TREAT RATE (g/m^3)	INJECTOR RANGE (g/m^3)	OUTPUT FUEL
F-34	S-1749	150 – 250	100 – 500	F-37

CONVERSION OF F-34 (ADDITIVE DEPLETED) TO F-34

INPUT FUEL	ADDITIVES REQUIRED	TREAT RATE (g/m^3)	INJECTOR RANGE (g/m^3)	OUTPUT FUEL
F-34 (ADDITIVE DEPLETED)	S-1745	1000 – 1500	500 – 2000	F-34
	SDA	1 – 5 *	10 – 50 **	

* Only 5 g/m^3 maximum shall be added to a single batch of F-34 during its life. Before redosing with SDA the original treat rate should be established so that any further additions do not exceed 5 g/m^3.
** Pre-diluted at 10:1.

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SECTION 5 ADDITIVE INJECTION REQUIREMENTS FOR GROUND FUELS

General

1. The preferred fuel for the implementation of the NATO Single Fuel Policy is F-34. However some Nations require that F-34 be treated with a multi-purpose additive (S-1750) in order to enhance the cetane and lubricity properties of the fuel prior to its use in ground equipment. Fuel treated with S-1750 is designated F-63 for segregation purposes to avoid the possibility of entry into aviation systems. F-63 must not be used for aviation purposes and management of equipment for the injection of S-1750 must be controlled to eliminate the possibility of introducing the additive into air systems. When F-34 or F-35 is not available, F-44 may be converted to F-63 by the addition of S-1750 in the same blend ratio.

Additives for Ground Fuels

2. Multi-purpose Additive: Diesel Engines S-1750. Additive S-1750 is a dual function additive designed to improve the lubricity and Cetane Number of aviation turbine fuels in the ground fuel mode. The additive is pre-diluted and no problems for injection equipment are anticipated.

Injection Ratio Adjustment

3. The equipment shall be capable of continuous and variable adjustment to achieve the following:

NATO CODE	PRODUCT DESCRIPTION	Required treat rate of additive in the final fuel blend (g/m^3)		Injector range adjustment (g/m^3)	
		MIN	MAX	MIN	MAX
S-1750	Multi-purpose Additive: Diesel Engines	800	1200	500	2000

Performance Requirements

4. The equipment shall meet all performance requirements of Section 2 and if air transportable Section 3.

Fuel Conversion Chart

5. A chart for converting F-34, F-35 or F-44 to F-63 is at page 5-2.

CONVERSION OF F-34/F-35/F-44 TO F-63

INPUT FUEL	ADDITIVES REQUIRED	TREAT RATE (g/m^3)	INJECTOR RANGE (g/m^3)	OUTPUT FUEL
F-34/F-35/ F-44	S-1750	800 – 1200	500 – 2000	F-63

SECTION 6 AVIATION AND GROUND FUEL CONVERSION CHART

INPUT FUEL	OUTPUT FUEL			
	F-34	F-35	F-37	F-63
F-34 (additive depleted)	S-1745 as required S-1747 as required SDS as required	-	-	S-1750
F-35 (additive depleted)	-	SDA as required	-	-
F-34	-	-	S-1749	S-1750
F-35	S-1745 S-1747	-	S-1745 S-1747 S-1749	S-1750
F-44	-	-	-	S-1750

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