

Unleaded Aviation Gasoline
CAA / UK September 25 2012

HJELMCO OIL AB
Lars Hjelmcö
Executive Director

Aviation Gasoline
=
AVGAS
versus
Car Gasoline

Aviation Gasoline

Tailored to meet challenges at surface all the way up to 35,000 feet anywhere in the world

Why Aviation Gasoline and not Car Gasoline ?

- Higher octane
- Lower vapor pressure
- No ethanol
- Lower freezing point
- Guaranteed energy content
- Tailored distillation

Why Aviation Gasoline and not Car Gasoline ?

- Better storage stability
- Less corrosive
- Known hydrocarbon components
- World-wide standardized product (Def Stan 91-90, ASTM D910)

The Problem

Aviation Gasoline 100 Octane Low Lead - AVGAS 100 LL

Typical Formula

- Alkylate ~ 70 %
- Isopentane ~ 15 %
- Toluene ~ 15 %
- **Lead**
- Dyes
- Scavenger
- Antioxidant

 } Additives

Sources of Lead Emissions example from the USA

Source	Percentage
Aviation	56.9%
Electricity generation/Boilers	15.1%
Industrial	25.5%
Other	2.5%

Source: 2002 Pb emissions and distribution from the EPA
Graphic: David Hjelmcö Hjelmcö Oil AB



Technical Backgrounds & Solutions



Dual Avgas Leaded/Unleaded

Unleaded – **low octane**

Unleaded – **high octane**



Dual AVGAS will not
eliminate lead but
may reduce lead to
safe levels.



Dual AVGAS

Benefits:

- Drop in replacement fuels for 100 LL
- Cheap to produce
- Known products
- Allows for slow elimination of leaded AVGAS during xx-years
- Allows for new a/c to be certified on UL94



Dual AVGAS
Gasoline Producers
Distributors
Airport Fuel Providers
take Investment Costs.



Single
Unleaded
Fuel Solution
Low Octane Route



Single Unleaded Fuel Solution Low Octane Route

- Hjelmcø 91/96 UL is an ~ 93 octane fuel similar to UL 94 as per ASTM test specification
- Increase octane to ~ 96 through adding mesitylene, ETBE, amines pending location in the world.
- Resulting fuel will be a fuel meeting 100 LL in "all" aspects except for 0-lead and octane.



Single Unleaded Fuel Solution The Fleet (Estimate)

- ~ 90% = req. AVGAS 80+91
- ~ 5% = req. 100 LL turbocharged
- ~ 4% = req. 100 LL non turbo
- ~ 1% = specials, war-birds etc.



~ 90% = req. AVGAS 80+91

**These are safe today
No cost.**



~ 5% = req. 100 LL Turbocharged

- Turbocharged engines have lower compression
- Proven in ground tests to give abt 95% power with 93 octane + intercooler + for certain engines electronic ignition system
- - 2.5% power was OK as per old certification criteria.
- Should be fine with 95 - 96 octane
- Perhaps certain restrictions in cylinder head temp
- Cost if intercooler added est. \$15,000 p. engine
- Additional cost elec. ign. est. \$15,000 p. engine



**~ 4% = req. 100 LL Non Turbo.
The Challenge
Possible options?**

1. Often same engine exists with lower c/r and less power due to lower pistons.
2. Decrease compression ratio (lower pistons) = less h.p. and increase displacement.
3. After market installation of turbocharger + intercooler ? + electronic ignition system? gives original power back.
4. Cost est. \$20,000 - \$45,000 per engine



GAMI Aftermarket Turbo & Inter-Cooler Installation in Cirrus SR22

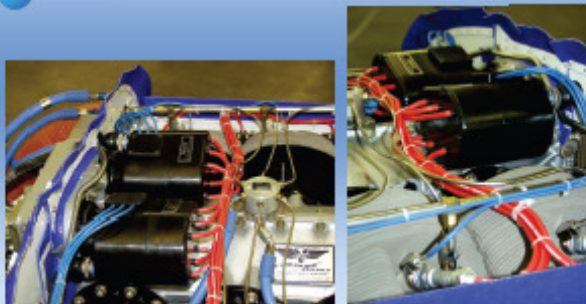


This is a turbo normalizer installation that will not increase power as suggested. This picture is only presented as a way to show an installation.

Source: GAMI



GAMI's Aftermarket Electronic Ignition System PRISM



~ 1% = Specials, War-Birds etc.

- An anti-detonation injection system methanol/water will give ~ + 12 octane
- Alternate way of cooling the engine
- Might require small amounts of lead due to non hardened valve parts in old engines
- Cost est. from \$15,000 and up per engine

ADI-system has the strength to cover 10% of fleet



**Petersen Aviation Inc.
Electronic ADI-System**



Source: Petersen Aviation Inc.



Single unleaded fuel solution

**low octane route
Aircraft owners take investment costs**



**Single Unleaded
Fuel Solution
High Octane Route**



There is yet **no** high octane unleaded AVGAS in development that 100% meets existing AVGAS standard Def Stan 91-90 or ASTM D910 but is without lead



Single unleaded fuel solution
high octane route
Fuel developers take the investment costs



**The Story of
Hjelmco 91/96 UL™
an Unleaded AVGAS**



Unleaded Avgas from Hjelmco Oil

Unleaded AVGAS 80

- Used in Sweden between 1981-1991
- Nationwide distribution and use
- More than 50 airports involved
- More than 400 aircraft
- Used by the Royal Swedish Air Force



**Cessna 172 Model 1973
Lycoming O-320 Engine**



**Cessna 150 Model
1968 Continental
O-200 Engine**



Source:
Aircraft of Sweden
Kjeller Länslinjen, Jönköping



Sweden 1991
Hjelmco Oil introduced unleaded aviation gasoline Hjelmco 91/96UL™

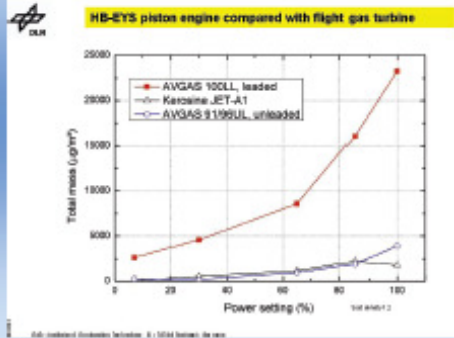
Reason:

80/87 UL potential market c:a 30%
91/96 UL potential market c:a 70%

2012 potential market > 90 %



EXTENSIVE SUPPORTING ENVIRONMENTAL DOCUMENTATION



1995 Textron Lycoming SI 1070 L

Service Instruction No. 1070L

TABLE OF SPECIFIED FUELS (CONT.)

Engine Models	SPECIFIED FUELS		Alternate Military and Commercial Grades
	Certificated For Use With Grade	Commercial Grade Designation	
O-320-B,-D; IO-320-B,-D; LJO-320-B1A; AEIO-320-D; AIO-320-A,-B,-C; O-400-A; O-360-A,-C; IO-360-B,-E; AEIO-360-B,-H; YO-360-A,-B; IYO-360-A; HO-360-A,-B; HIO-360-B; O-435-A2; GO-435-C2; O-540-A,-D,-E,-F,-G,-H; IO-540-C,-D,-N,-T; AEIO-540-D	91/96	100LL or 300	91/96 UL or 100/130 or 115/145

Mooney M20C
1970 Lycoming
O-360-A



Rockwell 114 Model
1977 Lycoming IO-540 T



Piper 28-161
Model 1988
Lycoming O-320 D

Source: www.mooney.com
www.rockwell.com
www.piper.com

Piper PA30/39 Twin Comanche Lycoming IO-320 B Engines



Piper PA44
Seminole
Lycoming
O-360A

Source: www.piper.com
www.semco.com
www.piper.com

Beech Duchess 76 Model 1979 Engine: Lycoming O-360A



Source: www.beech.com

Cessna Skyhawk Model 2012 Hjelmco 91/96 UL™ = OK



Source: www.cessna.com

Piper Archer-III Model 2012 Hjelmco 91/96 UL™ = OK



Source: www.piper.com

Diamond DA42 I360 Model 2012 Hjelmco 91/96 UL™ = OK



Source: www.diamond-air.com

Engines Suitable for Hjelmcø 91/96 UL

- Basically all aircraft engines up to 180 hp and between 230-260 hp. (see type-certificate)
- **Twin engine aircraft:**
 - Aztec, Cougar, Seminole, Duchess, etc.
- **Single engine aircraft:**
 - Piper Cherokee, Warrior, Archer, Cherokee six, Robin 100, Rockwell 114, Cessna 150, 172, 182 (exceptions exist) Socata Trinidad, Tobago etc.

Unleaded Hjelmcø 91/96 UL™

YEAR 2012

Existing, certified unleaded
AVGAS 91/96 UL (91/98 UL)
Extensive > 21 years flight-
experience

Recognized by the major US engine
manufacturer Lycoming in 1995

Sweden



Dual Avgas

Unleaded – low octane

Leaded – high octane

HJELMCO 91/96 UL

(Avgas 91/96 UL, Hjelmcø 91/96 UL, Avgas 91/96 UL)

MINIMUM

FARA

ÖLHVALD FLYGBENIN. FARLIGT VID INÄNDERING.

Mycket brandfarlig vätska och ånga. Kan vara dödlig vid inandning om det kommer ner i luftvägarna. Irriterar huden. Kan ge ett stort tillstånd eller smärtsamt. Muskelns kunna skada det dolda benet. Kan orsaka organiskador genom lång eller oregelbunden exponering. Mycket giftigt för vattenlevande organismer med långtidseffekter.

Även om inte produktens innehåller farliga och skadliga ämnen/ämnesblandningar. För inte utsläppa till vattenmiljöer/typen läggbara ytor - FÖRSLAG 13/13/13. Använda endast utrustning eller i väl ventilerade utrymmen. Undvik utsläpp till miljön. VID FÖRSTÄMNING. Kontakta genombildningsCENTRAL, telefon 112 eller lokala. Franska RTE linjen.

Innehåller: Metan + 80%, Metan innehåller 81 a-toluen + 20%, n-hexan + 0%, Isopentan + 20%, 2,2,4-trimetylpentan + 40%, 2,2,4-trimetylpentan + 12%, 2,2,3-trimetylpentan + 10%, n-hexyl-oxyl + 0%, styrol + 0%.

Leverantör: Hjelmcø Oil AB, Skovargatan 3, 701 32 Västerås TN, 021-12 31 70 © 2011-06-02

AVGAS 100 LL

(Avgas 100 LL)

MINIMUM

FARA

ÖLHVALD FLYGBENIN - FÄR ENASTÄ ANVÄNDAS SOM FLYGBENIN I ÖFTIGT VID INÄNDERING, HUDKONTAKT OCH FÖRTÄRING

Mycket brandfarlig vätska och ånga. Kan vara dödlig vid inandning om det kommer ner i luftvägarna. Irriterar huden. Kan ge ett stort tillstånd eller smärtsamt. Muskelns kunna skada det dolda benet. Kan orsaka organiskador genom lång eller oregelbunden exponering. Mycket giftigt för vattenlevande organismer med långtidseffekter.

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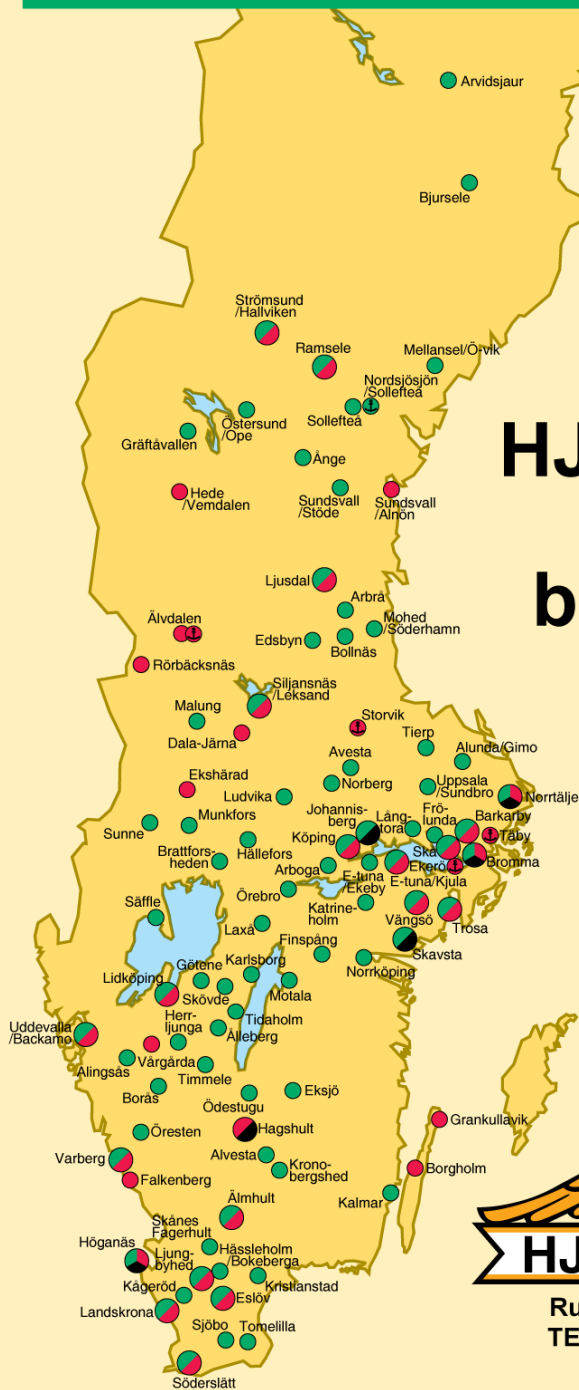
Leverantör: Hjelmcø Oil AB, Skovargatan 3, 701 32 Västerås TN, 021-12 31 70 © 2011-06-02

More to Read About
Unleaded AVGAS

www.hjelmcø.com

AVGAS 100 LL

HJELMCO 91/96 UL



HJELMCO OIL AB

Mycket mer än
bara flygbränsle!

- AVGAS 100 LL
- HJELMCO 91/96 UL
- JET-A1
- ⚓ sjöflyg



Runskogsvägen 4 B 192 48 SOLLENTUNA
TELEFON 08-626 93 86 • FAX 08-626 94 16
ORDERTELEFON 021- 12 31 76