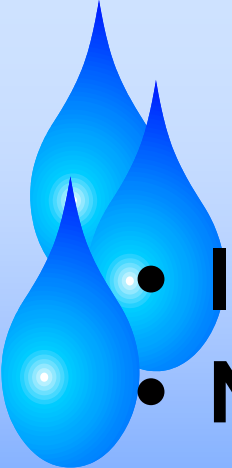


30 YEARS WITH UNLEADED AVGAS IN SWEDEN



LARS HJELMBERG



Hjelmco 91/96 UL

- **Introduced in 1991**
- **Nationwide distribution 1993**
- **Recognized by Lycoming 1995 (SI 1070)**
- **Flown > 1 million flight hours**
- **Available at > 70 airports**
- **used by ~ 1000 aircraft**
- **excellent technical history**
- **approved by piston engine manufacturers covering > 90 % of the entire world piston aircraft fleet.**
- **produced by Hjelmco Oil in Sweden**



EXTENSIVE SUPPORTING ENVIRONMENTAL DOCUMENTATION



MICROPHYSICAL AND CHEMICAL PROPERTIES OF NANOPARTICLES EMITTED BY FLIGHT ENGINES

Results from German PAZI Project

Claus Wahl

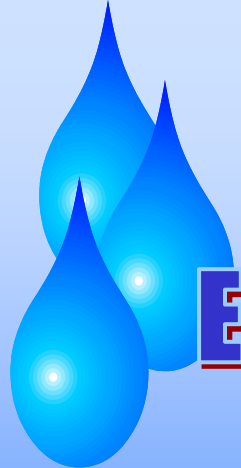
German Aerospace Center - Institute of Combustion Technology, Stuttgart, Germany

Theo Rindlisbacher,

Federal Office for Civil Aviation, Bern, Switzerland

Lars Hjelmberg,

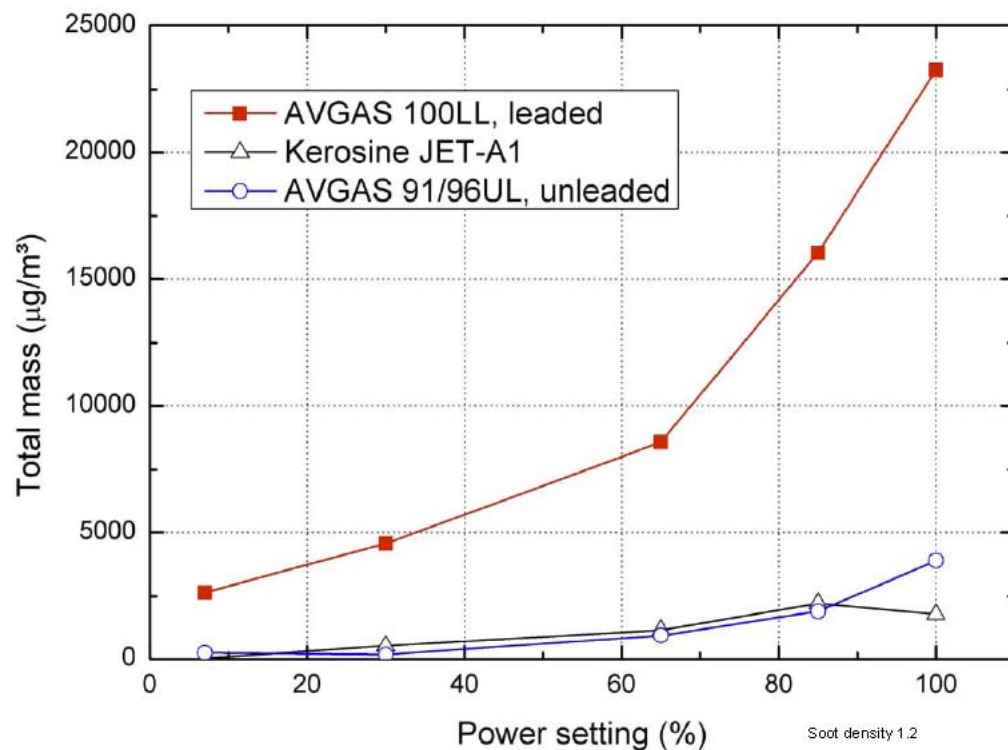
Hjelmco Oil AB, Sollentuna, Sweden



EXTENSIVE SUPPORTING ENVIRONMENTAL DOCUMENTATION



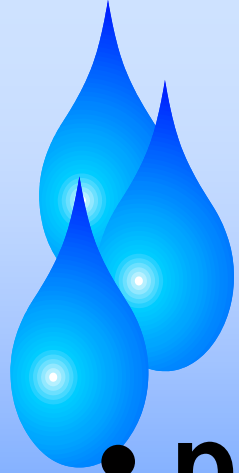
HB-EYS piston engine compared with flight gas turbine



EXTENSIVE SUPPORTING ENVIRONMENTAL DOCUMENTATION

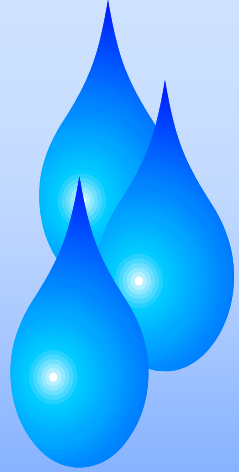


Picture 13: The measurement team. From left to right: C. Wahl, M. Kapernaum (both DLR), L. Hjelmberg (Hjelmco), T. Rindlisbacher, W. Bula (both FOCA)



Advantage for Hjelmeo Oil

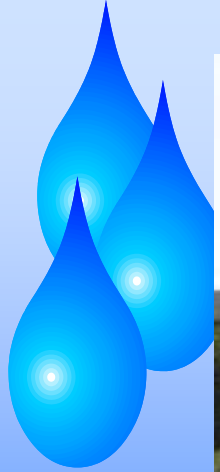
- **produces its own AVGAS** (also 100 LL)
- **own storage & distr. system**
- **own airport fuel installations**
- **could use existing AVGAS 80 fuel tanks for AVGAS 91/96 UL**
- **Swedish CAA support**
- **dedication – not profitability**



Break through 2010

by EASA SIB 31

If the unleaded AVGAS is a traditional AVGAS (D910) and as such approved by the engine manufacturer no extra approval is required from the air-frame type certificate holder or for orphaned aircraft.





HJELMCO 91/96 UL



HJELMCO 91/96 UL

"UNLEADED FUEL REQUIRES OIL ADDITIVE MEETING SPECIFICATION SJ 1400A. ADD ONLY TO -4STROKE ENGINE OILS"



MINIMUM

HJELMCO 91/96 UL

(Avgas 91/96 UL, Hjelmco 91/98 UL, Avgas 91/98 UL)



FARA

OBLYAD FLYGBENSIN. FARLIGT VID INANDNING.

Mycket brandfarlig vätska och ånga. Kan vara dödligt vid förtäring om det kommer ner i luftvägarna. Irriterar huden. Kan göra att man blir dåsig eller omtöcknad. Misstänks kunna skada det ofödda barnet. Kan orsaka organskador genom lång eller upprepade exponering. Mycket giftigt för vattenlevande organismer med långtidseffekter.

Använd inte produkten innan du har läst och förstått säkerhetsanvisningarna. Får inte utsättas för värme/gnistor/öppen låga/heta ytor. – Rökning förbjuden. Används endast utomhus eller i väl ventilerade utrymmen. Undvik utsläpp till miljön. VID FÖRTÄRING: Kontakta genast GIFTINFORMATIONSCENTRAL telefon 112 eller läkare. Framkalla INTE kräkning.

Innehåller: Nafta > 99%. Nafta innehåller bl.a. toluen < 25%, n-hexan < 5%, isopentan < 25%, 2,2,4-trimetylpentan < 40%, 2,3,4-trimetylpentan < 13%, 2,3,3-trimetylpentan < 10%, m/o/p-xylen < 9%, etylbensen < 2%.

Leverantör: Hjelmco Oil AB, Stuvargatan 9, 721 32 Västerås Tfn. 021-12 31 76 © 2011-06-02

AVGAS 100 LL

(Avgas 100 VLL)



FARA

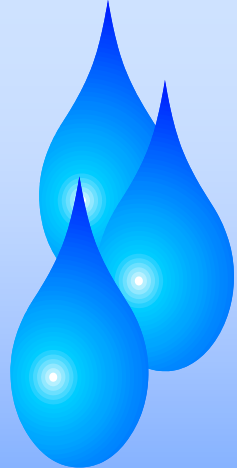
**BLYHALTIG FLYGBENSIN – FÅR ENDAST ANVÄNDAS SOM FLYGBRÄNSLE
GIFTIGT VID INANDNING, HUDKONTAKT OCH FÖRTÄRING**

Mycket brandfarlig vätska och ånga. Kan vara dödligt vid förtäring om det kommer ner i luftvägarna. Irriterar huden. Kan göra att man blir dåsig eller omtöcknad. Misstänks kunna skada det ofödda barnet. Kan orsaka organskador genom lång eller upprepad exponering. Mycket giftigt för vattenlevande organismer med långtidseffekter.

Använd inte produkten innan du har läst och förstått säkerhetsanvisningarna. Får inte utsättas för värme/gnistor/öppen låga/heta ytor. – Rökning förbjuden. Används endast utomhus eller i väl ventilerade utrymmen. Undvik utsläpp till miljön. VID FÖRTÄRING: Kontakta genast GIFTINFORMATIONSCENTRAL telefon 112 eller läkare. Framkalla INTE kräkning.

Innehåller: Nafta > 99%, bly < 0,56 gPb/L, 1,2 dibrometan < 0,43 gBr/L. Nafta innehåller bl.a. toluen < 17%, n-hexan < 5%, isopentan < 18%, 2,2,4-trimetylpentan < 31%, 2,3,4-trimetylpentan < 35%, *m/o/p*-xylen < 9%, etylbensen < 2%.

Leverantör: Hjälmco Oil AB, Stuvargatan 9, 721 32 Västerås Tfn. 021-12 31 76 © 2011-06-02



AVGAS 100 LL

HJELMCO 91/96 UL

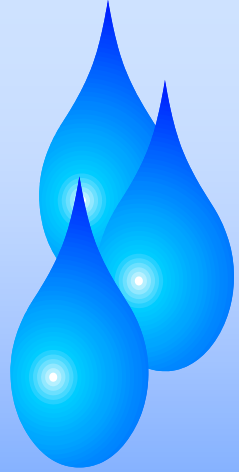
JET-A1

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

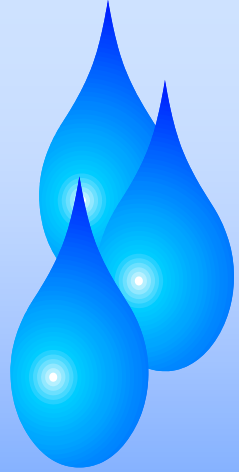


Unleaded AVGAS from Hjelme Oil

1 st generation launched 1981 80/87

2 nd generation launched 1991 91/96

**3 rd generation in progress BUT
may not be necessary.**

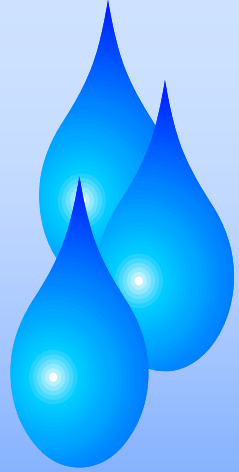


Unleaded AVGAS from Hjelme Oil

American AVGAS standard

ASTM D910

**is the aviation gasoline standard
to which Lycoming and
Continental aircraft engines
among others are type-
certificated to.**

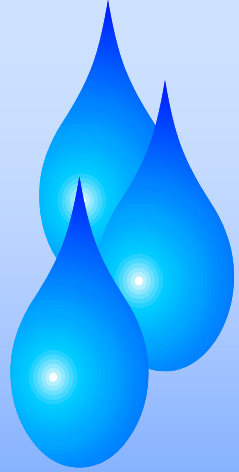


Unleaded AVGAS from Hjelme Oil

American AVGAS standard

ASTM D910-81

”If mutually agreed upon between the purchaser and the supplier, Grade 80 may be required to be free of tetraethyl lead. In such case, the fuel shall not contain any dye and the color as determined in accordance with ASTM Method D 156, Test for Saybolt color of Petroleum Products (Saybolt Chromo meter Method) shall not be darker than + 20”



Unleaded AVGAS from Hjelme Oil

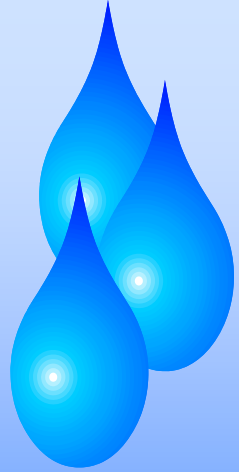
American AVGAS standard

ASTM D910 today = leaded standard

Regarding lead the standard does only stipulate a maximum amount.

No minimum amount of lead is stated

Thus: “Unleaded” AVGAS fits the AVGAS standard with trace amounts of lead ($< 0,013$ gr Pb/liter)



Unleaded AVGAS from Hjelme Oil

Unleaded AVGAS 80

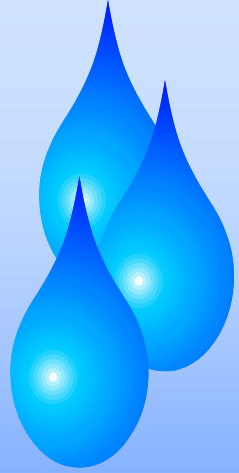
Used in Sweden between 1981-1991

Nationwide distribution and use

More than 50 airports involved

More than 400 aircraft

Used by the Royal Swedish Air Force



Unleaded AVGAS from Hjelme Oil

UNLEADED AVGAS 80

ADVANTAGES

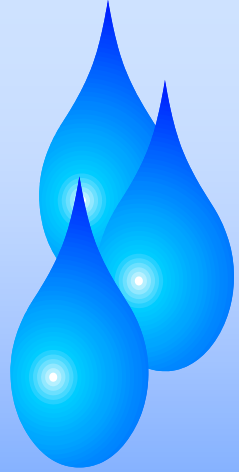
No lead in the exhaust

No lead in the engine

Minimized valve problems

Improved TBO

Environmentally sound.

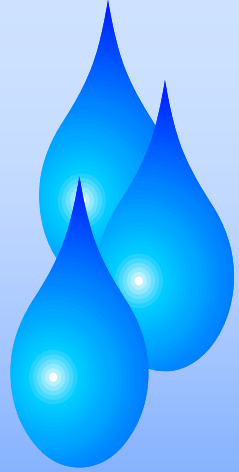


Unleaded AVGAS from Hjelme Oil

UNLEADED AVGAS 80

DISADVANTAGES

**PILOTS TEND TO
RUN ENGINES RICH**



Unleaded AVGAS from Hjelme Oil

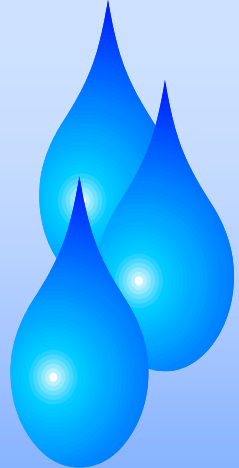
UNLEADED AVGAS 80

PROBLEMS

**SOME OLD ENGINES NEED LEAD
DURING BREAK-IN**

SOLUTION

USE AVGAS 100 LL DURING BREAK-IN



Unleaded AVGAS from Hjelmco Oil

UNLEADED AVGAS 80

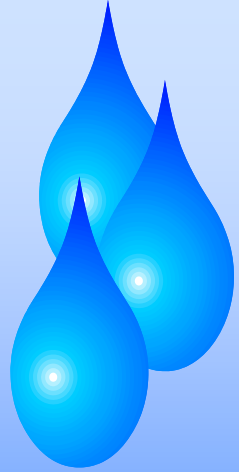
Produced in

Czechoslovakia 1981-1985

East-Germany (DDR) 1985-1992

for Hjelmco Oil

meeting US standard ASTM D910



Unleaded AVGAS from Hjelme Oil

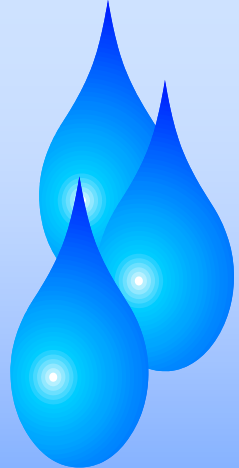
UNLEADED AVGAS 91/96

Introduced spring 1991

Flight tested by the

Royal Institute of

Technology in Stockholm

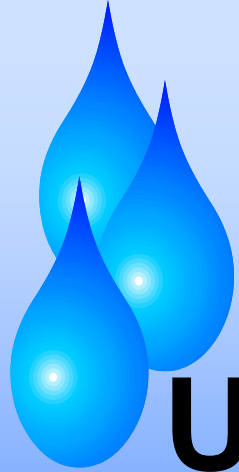


Unleaded AVGAS from Hjelmeo Oil

UNLEADED AVGAS 91/96

Produced in Finland 1991-1998

Currently produced in Sweden

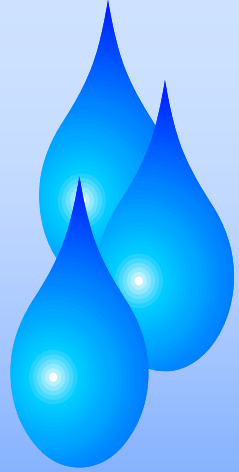


Unleaded AVGAS from Hjelme Oil

UNLEADED AVGAS 91/96

**Swedish CAA operational
conclusions 1999 (after 8 years)**

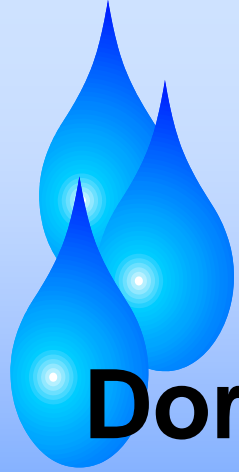
**Reproduced from "Alternative
Aviation Gasoline seminar in
Brussels" sponsored by the FAA
year 2000**



Unleaded AVGAS 91/96

**Changing from LL to UL
AVGAS may create exhaust
valve wear if not performed in
a controlled way**

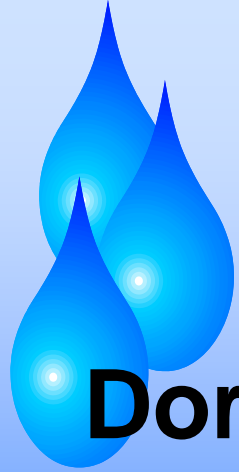
- Performance degrades in a controlled way and normally slowly.**
- Still no improbable condition has been recorded so far §23.1309 b**



Unleaded AVGAS 91/96

Dormant failures may be visible when changing from LL to UL AVGAS, due to decreased cooling margin, for example

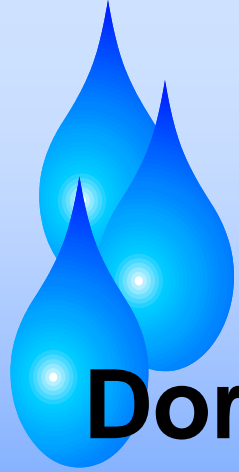
- **Inefficient cooling of engine and oil systems**
 - a) **Bad engineering**
 - b) **Poor maintenance**
- **One or two piece primary and main venturi, one piece venturi in some cases produce weak mixture.**



Unleaded AVGAS 91/96

**Dormant failures may be visible when
changing from LL to UL AVGAS
due to decreased cooling margin,
for example**

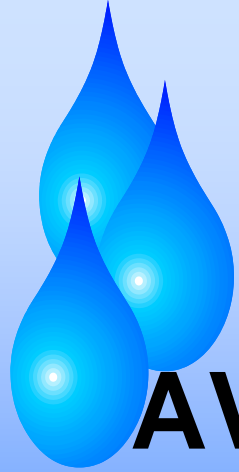
- **Low fuel level in carburettor**
- **Deficiency in heat transfer between valve guide and cylinder head**
- **Mismatched exhaust systems**
- **Poor quality of PMA spare-parts.**



Unleaded AVGAS 91/96

Dormant failures may be visible when changing from LL to UL AVGAS due to decreased cooling margin, for example

- **Engine manufacturers do not want to recommend designated oils or additives for use together with UL AVGAS, but for one exception! (the only factor known so far introduced by 91/96 UL itself)**
- **Fuel systems may give incorrect fuel level due to slightly changed density of 91/96 UL**



Conclusions recorded 1999

AVGAS 91/96 UL had been used

- **for more than 8 years**
- **and had created less than 10 technical events during this period of time**
- **7 engine events in 384000 EH(FH), reliability $1,82 \times 10^{-5}$**
- **and had created less problems than 100 LL when it was introduced in the seventies.**



Conclusions recorded 1999

**HJELMCO AVGAS 91/96 UL can be used
if:**

- **Minimum certified engine grade
AVGAS is 91/96 or lower**
- **Engine including installation and
cooling is healthy**
- **High quality engine oil recommended
for operation with UL fuel**
- **Oil additive is used**

➤ SAFE OPERATION



Engines suitable for Avgas 91/96 UL

Basically all aircraft engines up to 180 hp and between 230-260 hp. (see type-certificate)

Twin engine aircraft:

Twin-Comanche, Aztec, Cougar, Seminole

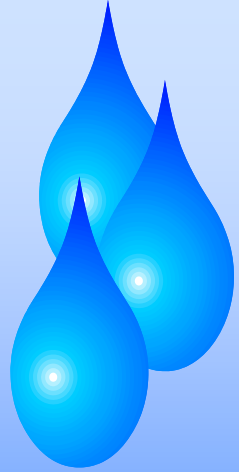
Single engine aircraft:

Piper Cherokee, Warrior, Archer,

Cherokee six, Robin 100, Rockwell 114,

Cessna 150, 172, 182 (exceptions exist)

Socata Trinidad, Tobago etc.



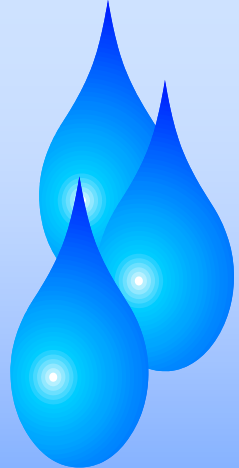
Unleaded Hjelmeo 91/96 UL

YEAR 2011

**Existing, certified unleaded
AVGAS 91/96 UL (91/98 UL)**

**Extensive > 20 years flight-
experience**

Recognized by Lycoming in 1995



Unleaded Hjelmeo 91/96 UL

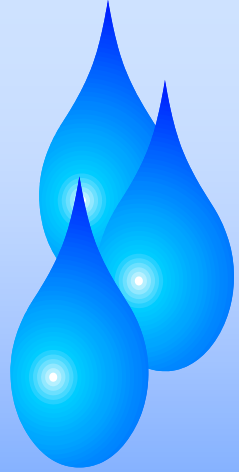
Pure hydrocarbon fuel

Made from current

**low-cost, environmentally sound
aviation gasoline components.**

NO

**ETHANOL, MTBE, ETBE, TAME,
SYNTHETIC COMPOUNDS etc.**

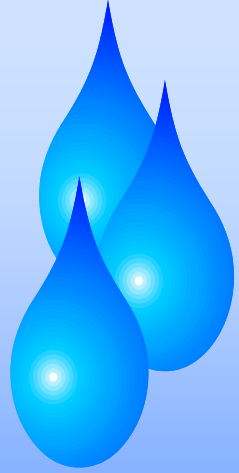


Help politicians

**Classify aviation
fuel-products
based on their
environmental qualities**

=

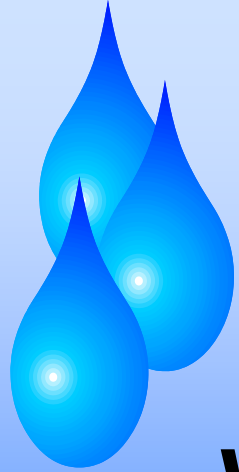
**statistical number for unleaded
AVGAS**



Help politicians

**With an environmental
classification of aviation fuels**

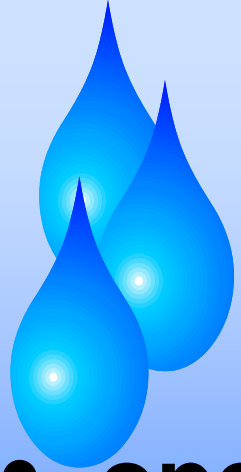
**allow tax-breaks
for environmentally
better products**



Help politicians

**With classification and tax-break
in hand**

**Regulators must take responsibility
and propose
system that will create
an European market**

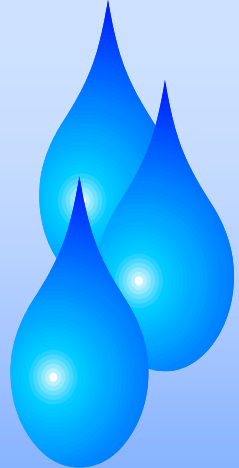


The friendly PA-28 Warrior

- **operates on unleaded
AVGAS 91/96 UL**
- **overall noise reduced by > 65 %**
- **reduced fuel consumption 7- 8 %**
- **maintains 75% power at 11000 feet**
- **no performance degradation**

**The friendly Piper Warrior II
on unleaded AVGAS Hjelmsco
91/96 UL since 1991**





Thank you for your attention



LARS HJELMBERG