SUMMARY OF MARITIME BENEFITS IN USING SOLTRON

1. Cleaner, more efficient engine
2. Lower maintenance costs
3. Savings arising from 1. & 2.

1. A cleaner, more efficient engine

Even with reasonable fuel, fuel treatment where applicable (filtration, separation and heating) and good lubrication, wear still occurs on engine cylinders / liners, piston rings and piston ring grooves, valve stems, valve guides/bushes.

A clean engine has minimal emissions, less carbon on disassembly, minimal wear and will require fewer parts renewed.

The reverse is also true: incomplete combustion leads to a progressive deterioration in engine performance and efficiency, increased wear on engine components and more parts required at overhaul. A build up of carbon leads to worn liners, worn piston ring grooves, sticking and or broken rings.

Use of Soltron dramatically improves combustion:

- Fuel quality: action of enzymes on fuel improves ignition and combustion qualities.
- Sulphur: Soltron reduces sulphur dioxide and trioxide in exhaust gases by up to 50%, thus halving erosion problems in cylinder components, turbo-charger casings & nozzle rings, exhaust systems and exhaust gas boilers/economisers. Sulphur in the fuel is chemically bound and is emitted as harmless sulphates.
- Vanadium: with proper combustion, cylinder and exhaust temperatures are normal for load. The formation of Vanadium is reduced and does not pose a problem for exhaust valves and turbo-chargers.

2. Lower maintenance costs

Fewer spare part requirements, longer intervals between services or overhauls.

Soltron maintains fuel systems:
- eliminates sludge in fuel tanks and reduces sludge discharge from separators.
- Injectors and fuel pumps remain clean and spindles, pump plungers & barrels suffer less wear.
- At fuel injection, the droplet size is reduced giving better than normal atomisation at the injectors, again improving combustion.

Lubricating oils.

In addition to lubricating and cooling, lubricating oils are formulated to neutralise acidic products of combustion and thus protect against wear and bearing damage.
Filters and centrifugal separation will remove much of the carbon but do not replace additives in the lubricating oil to maintain a safe value of TBN, and thus prevent wear and bearing damage. The only remedy is a partial or complete change of lubricating oil charge. The better the combustion, the better the condition of liner, rings and piston and the less blowby, and less carbon and exhaust gas contaminating the lubricating oil.

3. Savings arising from 1. & 2.

Some have been mentioned above. Other savings include, less downtime, less labour costs and last but not least - savings from reduced fuel consumption.

This saving can be significant, obviously dependent on fuel cost and relative condition of engine before use of Soltron. The change in performance and efficiency in an engine, which was steadily getting worse, can appear dramatic, but even in a new engine Soltron reduces emissions and gives an increase in fuel economy. Discounting fuel economy, Soltron has excellent long-term benefits for marine engines.

The "catalytic" components of Soltron are enzyme-derived compounds.

The compounds are structured proteins, built up from carbon, hydrogen, nitrogen and oxygen and cannot, even if too much Soltron is added to fuel, damage an engine.
Too much Soltron will further reduce emissions but the fuel saving will be less than optimum.

In marine applications with centrifugal separators, Soltron will not be ejected but will continue through the fuel system continuing its work.

The kerosene component of Soltron acts as a carrier. It is a mild solvent that allows the enzymes access to sludge sediments in fuel tanks. Aggressive solvents are to be avoided especially where cyclic stresses occur, as in engines.

Summary of Japanese Marine Reports on Soltron

- **Report on Japan Maritime Safety Agency Patrol Boats**

Report is based on engine overhauls of 2 patrol boats and emission tests on 3 boats over a six month period.

The Agency has 4 patrol boats, sister ships, of which only one, the Isozuki, used Soltron.
Each patrol boat has 3 main engines:-
12 cylinder, 200mm. bore, Mitsubishi 12 DM 20 MTK, of 1,000 PS @ 1,500 RPM
Fuel - diesel. Japanese "A" fuel

Emission reports

Measurements of smoke density of exhaust gas by Bosch type smoke tester taken at exhaust manifold.

Isozuki - 2 years after overhaul but using Soltron for 6 months

Akizuki - 1 year after overhaul

Urayuki - immediately after overhaul by Myoko Machine Ind. and Soltron just added

RPM	**Akizuki**	**Isozuki**	RPM	**Urayuki**

600	0.32	0.25	950	0.25
650	0.25	0.18	1190	0.32
800	0.28	0.24	1360	0.46
1000	0.38	0.28	1500	0.48
1200	0.48	0.36		
1400	0.62	0.45		

Main Engine Overhauls.

Comparison of condition of main engines, with similar running hours since overhaul, on 2 patrol boats operating under similar conditions.

Isozuki - 2 years after overhaul and after using Soltron for six months

Hamazuki - 2 years after overhaul

	Hamazuki	**Isozuki**
Cyl. Covers	hard carbon coating	soft carbon powder
Piston crowns	very hard carbon	dry soft carbon coating
Valves	very hard carbon	almost clean, soft carbon
Injector nozzles	hard carbon coating	dry soft carbon coating
T/C seals	sticky carbon coating	clear and clean
Turbine-side	carbon fouling	dry soft carbon film
Exhaust system	sticky carbon coating	dry soft carbon film

Conclusions:

Soltron was considered to improve combustion and prevent loss of engine efficiency due to accumulation and adherence of carbon coatings in the engine.

The above overhauls and emission tests were witnessed by managers from both the Maritime Safety Agency and the company carrying out the tests and overhauls, Myoko Machine Industries.

Unfortunately the report did not include normal overhaul data, but given the relative conditions of the engines, it is obvious where one would expect the greatest wear. Photographs were taken.

Main engine overhaul report on 2 coasters:- both just under 500 GT, the Ohmine Maru and the Sumikai Maru.

Both ships ran on "A" / "C" blended oil. The Sumikai Maru used Soltron over a period of 5 months prior to main engine overhaul.

The report and photographs show the carbon deposits and fouling of the engine on the Ohmine Maru and the much better condition of the main engine on the Sumikai Maru. What is interesting is the following:-

	Ohmine Maru	**Sumikai Maru**
Main engine	Makita 1,600 PS	Makita 1,400 PS
Age of ship	>2 years	>12 years
Operation period	6,000 hours	43,000 hours
Since last O/H	6,000 hours	11,100 hours

The Sumikai Maru had almost double the running hours, was 10 years older and possibly over the engine manufacturers recommended hours for major overhaul and yet in better condition while running on blended fuel. Both engines were overhauled by engineering companies at shipyards or dry-docks, which would account for the big difference in hours between overhauls.

Ohtori Maru

This is a report on a 62,592 GT cargo ship, the Ohtori Maru, running on bunker "C" fuel i.e. HFO and using Soltron for 7 months.
Main engine is a Mitsubishi built RND 90 of 17,400 PS

The report (verbatim) –

1. The suction and exhaust ports were so clear that the mechanics were very surprised. Some deposits existed partly in the exhaust ports were fragile and easy to be removed.

2. The right photograph shows the piston, which had been used for about 9,000 hours. Some contamination found on the upper part are considered to be dripped oil.

The photograph shows all five rings clean and bright. "dripped" oil on the piston crown is normal when pulling a unit. It could be that the oil was not wiped off for fear of removing the light carbon on the crown at the same time and compromising the photograph.

Again no data on liner calibration and relative wear rates etc. but from the condition of piston and rings, cleanliness of exhaust and scavenge ports one could fairly assume that the general condition of the main engine was very good.

Car ferry Kanaya Maru.

Report on main engines overhaul of a car ferry, the 1,175 GT Kanaya Maru, with 2 off main engines Niigata 6M 31 AT, 1,600 PS, running on bunker "B" oil and using Soltron for 15 months.

The car ferry is only 21 months old but in its last year of service reports a reduction in fuel consumption of 4.89%.

This overhaul is after 4,700 running hours. As previous reports, absence of hard carbon coatings are noted. Cleanliness of engine and T/C noted, also suction and exhaust valves not changed since last overhaul. Fuel service tank found clean, fuel filters had not required cleaning since previous docking.

Y1 Maru & Y2 Maru

A report on main engine maintenance on deep sea fishing boats, the Y1 Maru & Y2 Maru with only the Y1 Maru using Soltron.

	Y1 Maru	**Y2 Maru**
Injector change	Per 4 voys. (2,590 hrs.)	Per 1 voy. (675 hrs.)
Lubricating oil change	Yearly	Half yearly
O/H in dock	Few carbon deposits, piston & liner good.	Hard carbon coating in combustion spaces.
Exhaust valves	Checked after 6 months, good for 1 year.	2 renewals in 1 year.
Suction valves	Good for 2 years.	Yearly overhaul required.

BT Maru, 96,000 GT ore carrier

A report on economiser cleaning on the 96,000 GT ore carrier, the BT Maru with Mitsui B & W 6L 80 MCE of 17,300 PS

Before addition of Soltron, economiser was water-washed every 637 hrs. Frequency of water-washing was gradually reduced and even at 1,470 hrs. no fouling was evident. In fact, period between cleaning could have been extended.

Also reported was absence of sludge in HFO bunker tanks and cleanliness of fuel filters. The WW Maru, a 20,000 GT car carrier reported that accumulated sludge in HFO bunker tanks was cleared by 2 years use of Soltron.

Fuel consumption

An accurate figure for fuel consumption on a vessel is very difficult due to day to day changes in operating conditions (currents, wind & weather, loaded condition).

The table below gives results from Japanese ferries operating in the Inland Sea.

GT.	Main Engine	Fuel Grade	Fuel Cons. w/o Soltron	Fuel Cons. with Soltron	Saving
975	2,000 PS x 2	"B"	2,167L/voy	2,040L/voy	5.9%
999	1,500 PS x 2	"B"	182.6L/hr	176.3L/hr	3.5%
1,175	1,600 PS x 2	"B"	173.4L/hr	166.6L/hr	4.0%
3,000	5,800 PS x 4	"A"	536.96L/hr	524.55L/hr	2.3%
5,000	10,400 PS x 2	"C"	586.93KL/m	569.18KL/m	3.0%

Notes:
These figures seem low. Considering fuel savings on boilers are up to 19%, one would expect savings to be much nearer to 10%. One likely factor will be that typical Japanese ferries are of barge-like, roro construction with twin screws and disproportionate shaft & prop. losses, when compared with a single screw vessel.

These reports are not recent and fuel quality is dropping. The bunker spec. may not have changed, but oil being a complex blend, the spec. only gives an average value. If it were to include max. and min. values, where applicable, it would give a more complete picture.

The percentage of ash given on a bunker spec. does not approximate to the amount of sludge found in practice. National authorities, that are keen on enforcing Marpol regs. invariably work on a conservative 3% sludge content of HFO.

Sludge formation. Residual fuels

The basic philosophy of minimising residual fuel oil yield creates problems in both light and heavy fuel oil.

In heavy fuel oil, these processes remove the solvent from the fuel oil thus producing insoluble solids in suspension. Besides creating tank bottom deposits, the insoluble solids also exist in suspension in the bulk of the oil and create a number of other serious problems.

Light fuel oil is now a blend of straight run and cracked products. The latter fractions contain more aromatic hydrocarbons which have a tendency to smoke with more olefinic hydrocarbons which are subject to oxidation of polymerisation to form gums and bacteria.

Soltron significantly reduces solids in suspension and prevents sludge formation at the bottom of reservoirs. Many solids are polar and have the tendency to agglomerate together forming large particles. Soltron’s enzymes break existing particles and prevents formation of new ones.

Soltron enhances fuel.

Its main properties are those of an organic surfactant and solvent.

- Being soluble and self-dispersing in the fuel, it very quickly starts working throughout the entire fuel system. Sediment, mainly asphaltenes, carbonised oil on heating coils, glazes

due to resins and gums in pumps, fuel pumps and injectors, are all slowly penetrated, dispersed and brought back into solution.

- As a surfactant, it coats all surfaces, fuel tanks, coils, piping etc., with a monolayer of Soltron. The reduced surface tension between Soltron/fuel as compared to steel/ fuel interface, gives a slight reduction in fuel viscosity.

- With water contamination, Soltron works as a de-emulsifier, separating water and fuel to allow drainage of the water. Water not only interferes with combustion and increases corrosion but as a source of oxygen, promotes bacterial growth as well as oxidation of the fuel. With Soltron dispersed through the fuel tanks and at the fuel/water interface, algae and bacteria can not survive.

Given a homogenous fuel with no solids entrained; injection, atomisation, ignition and combustion are much improved and emissions are less. The benefits to the engine follow-on from the resulting improvement.

Some of the Japanese Shipping Companies using Soltron

Name of Company	Ships using "C" oil		Ships using AC" blend	
	Nos.	DWT	Nos.	DWT
Kitakyushu Trans.	4	35,568	1	7,101
Kokka Ind.	2	2,600	11	12,441
Sanyo Marine Trans.	1	2,000	8	18,500
Sumikin Marine Trans.	5	8,419	39	59,458
Tarusaki Ind.	1	1,600	8	15,820
Nippon Marine Trans.	9	28,591	40	56,805
Hirohata Marine Trans.	11	18,300	12	19,500
Miyagawa Marine Trans.	4	10,000		
Yahata Ship	15	23,675	22	22,679

Department of Marine Engineering, Shipbuilding Polytechnic, Surabaya
Laboratory Test Results

Analysis of test data for exhaust gas output and fuel consumption of Diesel engine carried out over a two day period in the marine diesel laboratory, Shipbuilding Polytechnic of Institut Teknology Sepuluh

Engine type: Detroit Diesel Allison
Serial Number: 4A0249106
Capacity: 4.65 litres Fuels; High Speed Diesel (Diesel), HSD + Soltron

%CO

RPM	Diesel	Diesel + Soltron	
1340	9.40	7.25	-22.8%

$\%CO_2$

RPM	Diesel	Diesel + Soltron	
1340	12.70	9.40	-25.98%

$\%O_2$

RPM	Diesel	Diesel + Soltron	
1340	0.83	7.30	+879.5%

Output (Kw)

RPM	Diesel	Diesel + Soltron	
1340	65.90	69.45	+5.38%

Fuel Consumption (Kg/hr)

RPM	Diesel	Diesel + Soltron	
1340	16.50	13.46	-18.42%