ICOMIA Marine Engine Committee

PERSONAL WATERCRAFT SOUND TEST REPORT

JET SKI VILLAGE, FRANCE

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AUTHOR PWC Task Force

PERSONAL WATERCRAFT SOUND TEST REPORT 2003
At Jet Ski Village in France

Summary:
Following the successful sound test conducted in 2001, the IMEC PWC Task Force brought together five new Personal Watercrafts (PWC), by 3 manufacturers, which had since been developed and marketed in European Community since then. The units selected employed newly developed technology for PWC such as 4-stroke engines, the latest direct fuel injection technology, catalyze technology on a 2-stroke. The Sound test was conducted in pass-by mode per ISO 14509. The results confirm again that a satisfactory repeatability of the pass by sound levels can be attained for PWC's. These results also demonstrated once again the great efforts industry has made to further reduce the sound level on these products.

Background:
Upon the implementation of the Emissions Amendment to the Recreational Craft Directive 2003/44/EC (herein after the RCD) and prior to the sales in the EU, manufacturers of recreational craft are required to demonstrate compliance with the set sound limits. Manufacturers of complete craft PWC manufacturers in particular have a direct interest in the compliance with the RCD requirements. The 2001 test results demonstrated that the PWC's were close to the limit, but further improvement was needed to ensure all craft would comply with the new rules. With the development, incorporation and marketing of new technologies over the past 2 years, time had come to evaluate the progress.

Further more the inclusion of PWC's in the RCD will have an immediate impact upon national legislation in a number of EU member states. Not only from a constructional point of view but also in relation to usage.

Sound and PWC's have for a long time been unrightfully associated and still often. Now with ISO 14509 and the RCD Emissions amendment completed the PWC manufacturers were eager to demonstrate the further improvements made in recent years on newly released products since the in 2001.

Test Performed:

In recent years IMEC has investigated and conducted several sound tests pertaining to recreational craft. The purpose of this test session was not to gather more data to support further sound studies but to establish whether or not compliance with the new requirements can be achieved using new technology and to demonstrate the progress made by the industry in past 2 years.

Consequently the 3 manufacturers selected 5 models designed and/or produced after the model year 2003 and represent the latest available models on the European market. The range of models selected varied from 2 to 3 sit-down, propelled by 2 & 4-stroke engines equipped with fuel injection or the latest direct fuel injection technology as well as catalyser technology on a 2-stroke.

To comply with the strict test conditions set forth in the ISO 14590, Jet Ski Village in Villeneuve La Guyard, France was again selected as the test site. The site is conveniently located in the centre of France, with a test course laid out as shown in Fig. 1.

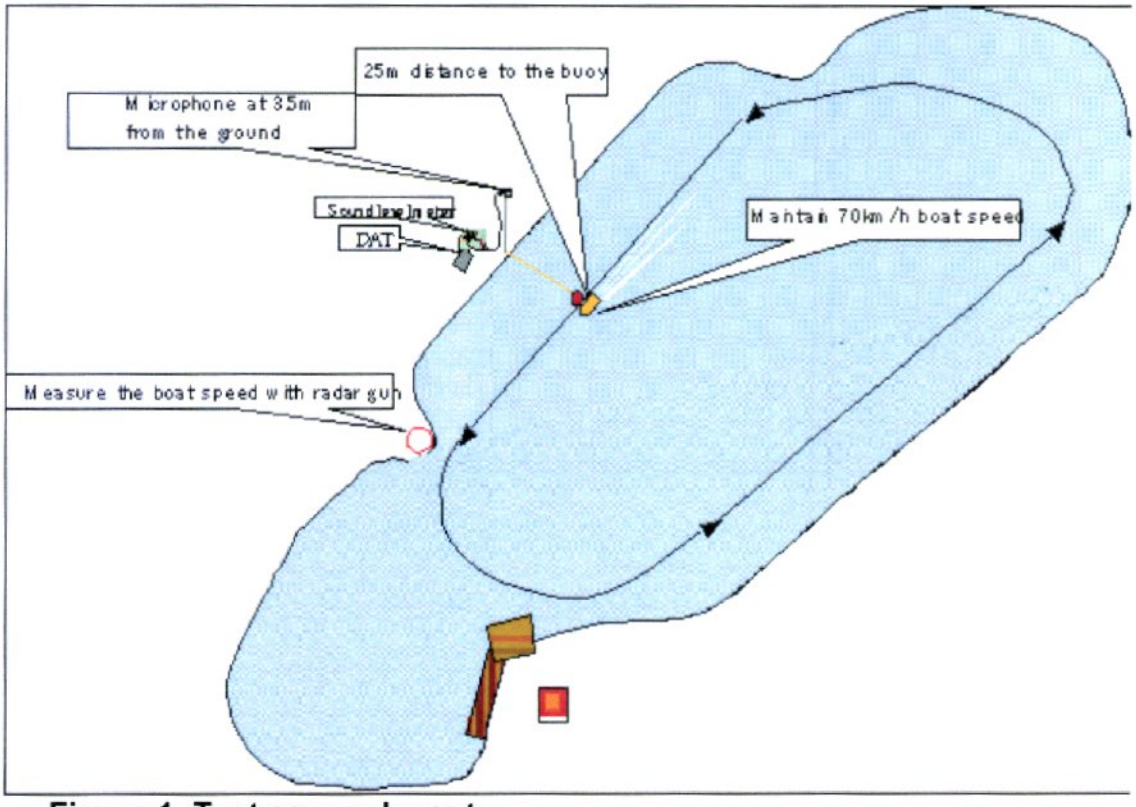


Figure 1. Test course layout.

As per ISO 14590 a pole was rigidly placed into the lake bottom close to the shoreline allowing microphones to be installed at 3.5 m +/- 0.5m above the water line. Attached to the post was a microphone, which was connected to a Brüel & Kjaer sound level meter. Located on a table, 2 meters within the range of the microphone. Sound test data was recorded on a DAT recorder, thereby providing a permanent record of each pass by

event.

The arrangement provided an excellent set up with minimal to no interference by ambient or waves breaking sound interference ensuring accurate and repeatable results.

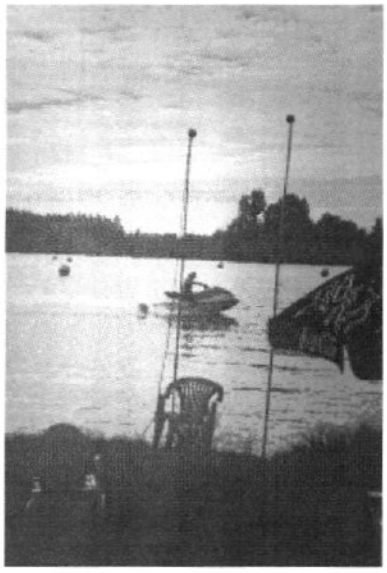


Photo 1. Microphone setting.

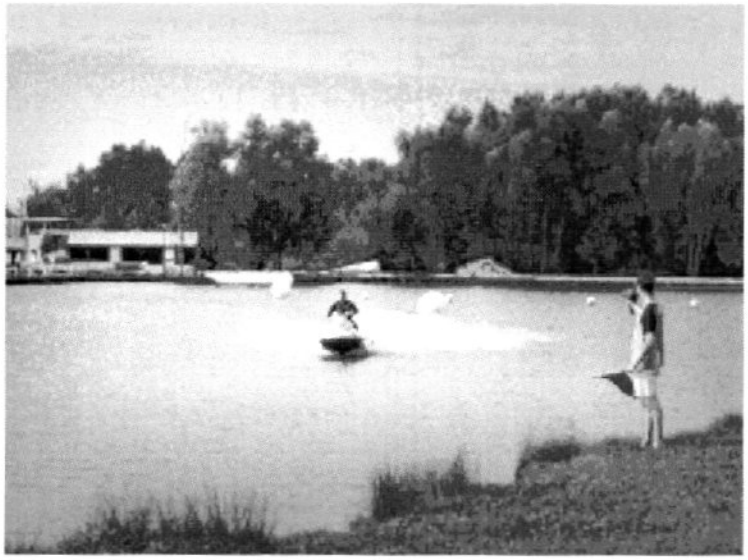


Photo 2. Verifying the boat speed with a radar gun & flag indication for PWC operator.

Once all set up the sound test were conducted in two sessions spread over two days. During the first day all craft made 10 runs past the test equipment (5 over starboard, 5 portside).

The second day was used for assessment of daily variations, therefore an additional 4 runs were made, again 2 over starboard and 2 portside.

All runs were done in strict accordance with ISO 14590 by a qualified sound technician, meaning that all craft were operated at the required 70 km/hr. The speed/engine rpm were initially established prior to the sound test and verified again during the test runs themselves.

Table 1 lists the crafts tested.

Craft No.	Engine	Engine technology	Measured Sound Level dB (A)
1	3 cylinder	2-stroke, EFI, catalyzer	70.2
2	4-cylinder	4-stroke, EFI	72,7
3	4-cylinder	4-stroke, EFI	71,7
4	3-cylinder	4-stroke, EFI	71,2
5	2-Cylinder	2-stroke, EFI	71

Notes:

1. Second day measurements indicated that environmental conditions, specifically change in wind direction, resulted in 1dB(A) variations (e.g. higher).

Table 2 Instrumentation

Instrument	Type	Capacity/setting
Integrating precision sound meter (conform IEC 60651)	Brüel & Kjaer Type **223 6**	Frequency range: 10 ~ 20000 Hz Measurement range: 20 ~ 143 dB Characteristics: Slow Sampling period: 10 ms
Sound pressure level calibrator (conform to IEC 60942)	Brüel & Kjaer Type 4231	
Radar Gun	Stalker ATS	
Sound Level Meter	Brüel&Kjaer Type 2230	Frequency range: 10 ~ 20000 Hz Measurement range: 20 ~ 143 dB Characteristics: Slow Sampling period: 10 ms
Analyzer Software	HEAD –Artemis V 3.0	
Digital Data Recorder	Racal Data Rec. A40	Frequency range: 0 – 24000 Hz

Note: Instrumentation was provided with recent calibrations.

Table 3 Test Ambient Conditions.

Conditions	Level
Temperature	**22°C**
Humidity	**53%**
Atmospheric pressure	**1017 hPa**
Wind speed	**< 3 m/s**

Table 4 Test Team

Name	Company	Function
Jan Matthiesen	ICOMIA/IMEC	Industry Observer/test equipment operator
Wolfgang Schrenk	Bombardier	Measurement Instrument Operator
Hans Sipkema	Kawasaki	Coordinator
Bas Spierdijk	Kawasaki	Test boat operator/mechanic
Daisuke Shimizu	Yamaha	Measurement Instrument Operator
Masaru Tamaki	Yamaha	Test boat operator
Christophe Touchet	Yamaha France	Test boat operator
J.C. Van Acker	Yamaha Netherland	Observer
Shane Tani	Yamaha	Observer
Naoki Furukawa	Yamaha	Observer

Table 5 Miscellaneous information

Description	Details
Location	Jet Ski Village in Villeneuve La Guyard, France
Date	1st & 2nd September, 2003

How were the sound reductions achieved?

Reducing sound does not come easy or by itself. Development in new engine technologies, have provided the manufacturers with new insights on how to achieve sound reduction on PWC's. The major advantage PWC manufacturers have over the rest of the marine engine industry is that they are designing a complete package: hull, driveline, engine and exhaust system are all carefully designed to work as one integrate part. Comparing these tested units with the previous units of the 2001 test will show increased exhaust muffler volumes, newly designed intake systems (longer, labyrinth like) to name but a few of the more apparent changes.

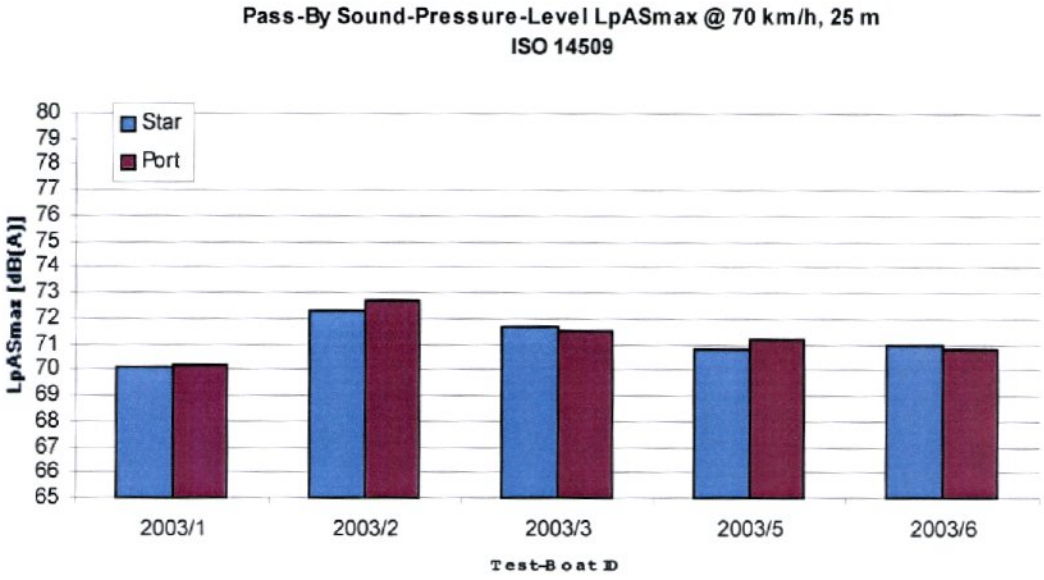
Data Analysis:

Sound level data obtained during the test are presented in the following graphs:

Graph 1. Pass-by Level, portside and starboard.

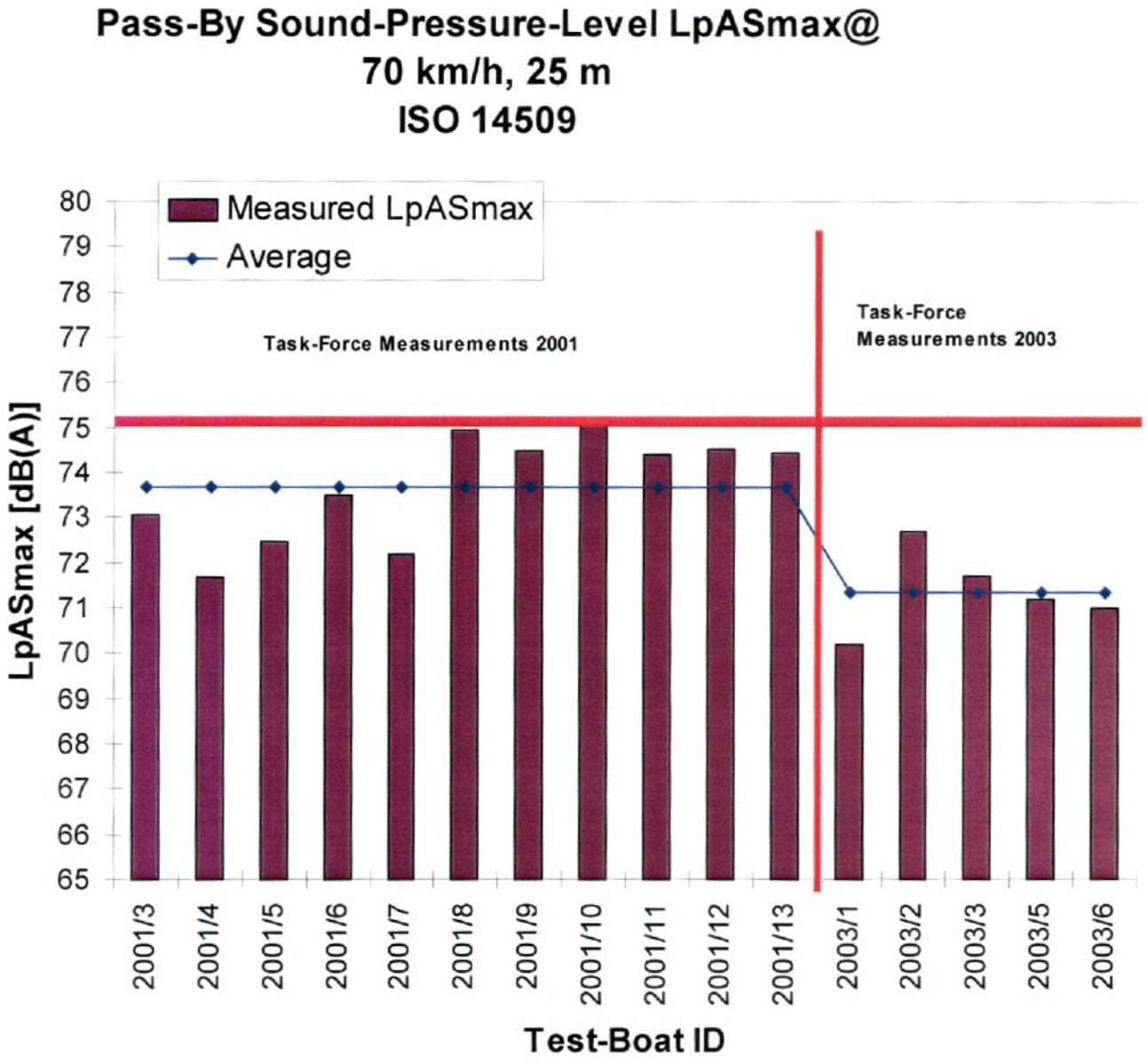
Graph 2. Pass-by Level at 70 km/hr –LpASmax,
Comparing 2001 to 2003 sound test results.

Graph 1. Pass by Level, portside and starboard.



All craft had exhaust port openings at the rear of the craft either on port or starboard side. All craft were capable of reaching 70 km/hr or more.

Graph 2. Pass by Level at 70 km/hr –LpASmax.



The LpASmax graph demonstrates the great improvement made since the test conducted in 2001.

Conclusion:

The 2003 IMEC PWC Sound Test confirms the results of the 2001 test. The RCD sound tests as per ISO 14590 could successfully be conducted for PWC. Objective assessment of PWC environmental (sound) impact was accomplished.

Although the sound test results show that the latest PWC's are in compliance with the requirements, industry still needs further development to ensure compliance once the new rules are introduced and implemented, keeping in mind market demand and trends.

As a general observance and in support of earlier gained experiences from IMEC Sound Tests, the test results are (significantly) influenced by wind speed, wind direction and the hull impact noise at greater speeds.

To anticipate future sound regulations, a further structured approach to sound limit studies is needed, taking into consideration new developments in engine technology, material and market demand.