Benirall PMV Project Outline

1. Objective

To design manufacture and test an EmDrive propelled Personal Marine Vessel (PMV).

2. PMV description

The vessel is based on a Hobie Cat 16 sailing catamaran with the sails removed and propelled by a superconducting EmDrive Thruster. The Thruster is based on a 2.45GHz, 200mm diameter version of the SPR Ltd Cubesat TE113 design.

The PMV is illustrated in Fig.1.

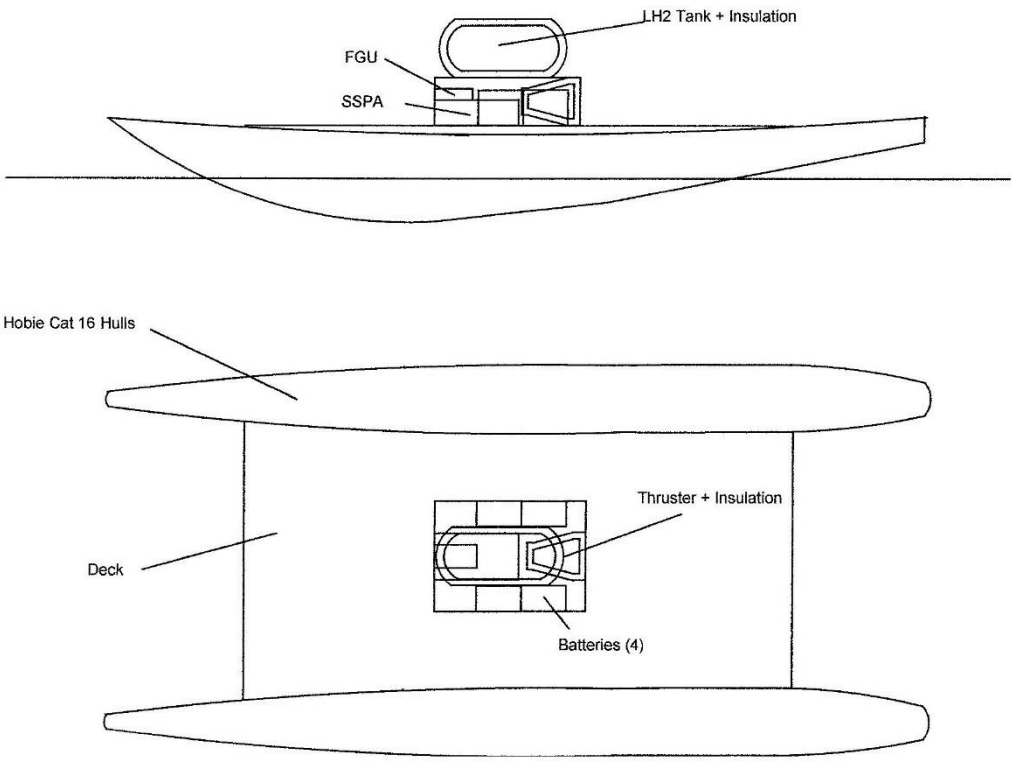

Fig.1

The major components are

Hobie Cat 16 hulls with lengthened deck.

Thruster insulated to operate down to 20deg K using Liquid Hydrogen (LH2) cooling.

30 litre LH2 tank, insulated to minimise boil-off.

Frequency Generator Unit (FGU) providing microwave signal controlled by a digital processor.

900W Solid State Amplifier (SSPA).

4 off 12Volt 90Ah Lithium batteries.

The PMV will be capable of reaching a typical LNG Tanker speed of 20 knots, with the thruster running below maximum power. At maximum power the vessel will have a duration of approximately 40 minutes. The Test vessel illustrated in Fig.1 has a mass of approximately 250kg.

Fig.2 shows the basic test vessel fitted with a cabin to enable manned demonstration trials.

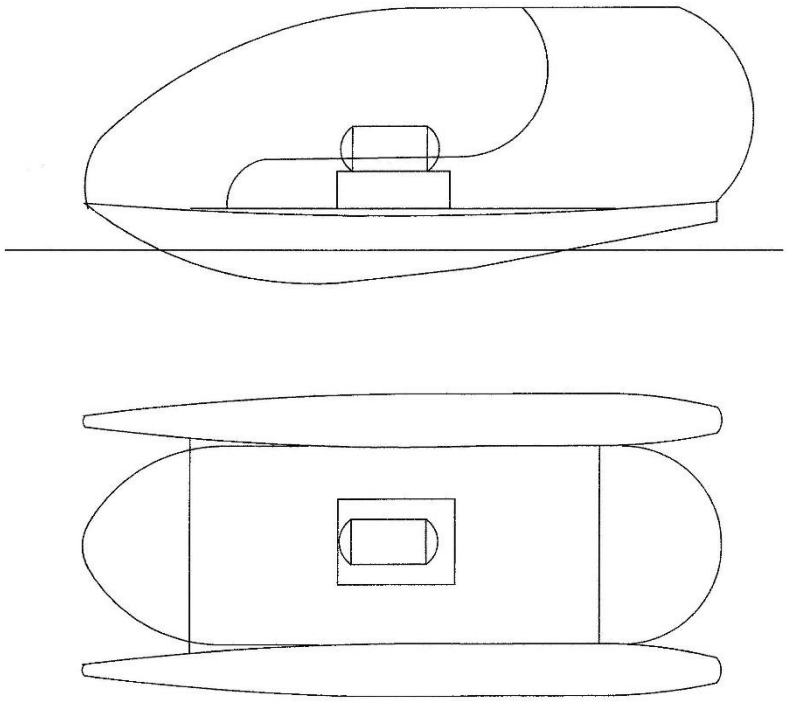

Fig.2

Overall length of the vessel shown in Fig.2 is 5.3m, overall width is 2.4m. Cabin width is 1.6m and cabin height 1.6m.

3. Project Plan

Phase 1. Study

It is proposed that the project starts with a study phase which will include a short residential training course in the UK, given by SPR Ltd. At the end of Phase 1, the design team will fully understand EmDrive physics, and have developed their own version of the software necessary to design the microwave cavity. All information for the study phase is available in standard microwave text books and in published papers, however it has been found that considerable study effort is required to build up the necessary competence for a project of this nature. Phase 1 will take 3 months for a minimum team consisting of Team Leader, Microwave Engineer and Mechanical Engineer. All team members must be fully qualified and experienced Engineers.

Phase 2. Design

This phase will result in the preparation of full manufacturing drawings for the ambient temperature thruster and all components and suppliers being specified. In addition the test equipment will need to be on order as there are typically long lead times for some microwave components.

The test balance will be designed and the test team assembled. Phase 2 will take a further 3 months.

Phase 3. Manufacture

The thruster cavity will be machined and measured. This will require subcontracting to a high precision machine shop. Once the cavity dimensions are confirmed, the components will require polishing and silver plating by a specialist subcontractor.

Test balance components will be manufactured and test procedures prepared.

Another 3 months is estimated for phase 3.

Phase 4. Assembly

By the end of the first year it is planned that the thruster will be fully assembled and the test balance and associated test and data recording equipment will be verified and calibrated.

Phase 5. Ambient Temperature Tests.

Over the next 6 months the thruster will be tuned and aligned, and a set of thrust measurements will be carried out.

During this period the design will be updated to include YBCO superconducting components. These components need to be procured from a specialist supplier. The liquid Nitrogen (LN2) and Liquid Hydrogen equipment will be procured and assembled. A local supplier of these liquid gases will need to be placed on contract, to supply at short notice.

The basic Test Vessel will also be procured and modified to accommodate the EmDrive engine.

Phase 6. LN2 Tests

The Thruster will be updated to include the superconducting components and tested on the beam balance, updated to carry the cooling system. The engine will then be assembled on to the vessel.

The vessel will undergo drag tests, to enable the subsequent thrust data to be calibrated.

A series of acceleration tests will be carried out at increasing power levels, with performance being analysed from films of the tests. During initial testing, it is envisaged the vessel will be under remote control.

This phase is estimated to take 9 months.

Phase 7. LH2 Tests

The engine cooling will be changed to liquid Hydrogen, with all the necessary safety procedures being rigorously applied. The engine will be retested on the beam balance. A second series of acceleration tests will be carried out using reduced power levels. This phase will last 6 months.

Phase 8. Demonstration Trials

During this phase, the cabin structure will be assembled on to the test vessel, and fitted out for customer demonstrations. Subsequent manned trials will be carried out. A further 3 months is estimated for this phase.

4.Project Schedule

The overall schedule is illustrated in Fig.3.

Phase No	Phase	Month											
		3	6	9	12	15	18	21	24	27	30	33	36
1	Study												
2	Design												
3	Manufacture												
4	Assembly												
5	Ambient tests												
6	LN2 Tests												
7	LH2 Tests												
8	Demonstration Trials												

Fig.3