

**UNIVERSITI TEKNOLOGI MALAYSIA**  
**Research Management Centre**

**PRELIMINARY IP SCREENING & TECHNOLOGY ASSESSMENT FORM**

*(To be completed by Project Leader submission of Final Report to RMC or whenever IP protection arrangement is required)*

**1. PROJECT TITLE IDENTIFICATION :**

Design and Development of Pumps for Power Plant and Cars\_\_\_\_\_

Vote No:

72124

**2. PROJECT LEADER :**

Name : Prof. Ir. Dr. Alias Mohd. Noor\_\_\_\_\_

Address : Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 UTM  
Skudai, Johor D.T\_\_\_\_\_

Tel : 07-5534567\_\_\_\_\_ Fax : 07-5566159\_\_\_\_\_ e-mail : alias@fkm.utm.my

**3. DIRECT OUTPUT OF PROJECT** *(Please tick where applicable)*

Scientific Research	Applied Research	Product/Process Development
<input type="checkbox"/> Algorithm	<input type="checkbox"/> Method/Technique	<input checked="" type="checkbox"/> Product / Component
<input type="checkbox"/> Structure	<input checked="" type="checkbox"/> Demonstration / Prototype	<input type="checkbox"/> Process
<input checked="" type="checkbox"/> Data		<input type="checkbox"/> Software
<input checked="" type="checkbox"/> Other, please specify Governing Equation	<input checked="" type="checkbox"/> Other, please specify Product Design	<input checked="" type="checkbox"/> Other, please specify Improve I.C. Engine performance and save fuel consumption
_____	_____	_____
_____	_____	_____

**4. INTELLECTUAL PROPERTY** *(Please tick where applicable)*

- |  |  |
|--|--|
| <input type="checkbox"/> Not patentable                    | <input type="checkbox"/> Technology protected by patents |
| <input checked="" type="checkbox"/> Patent search required | <input type="checkbox"/> Patent pending                  |
| <input type="checkbox"/> Patent search completed and clean | <input type="checkbox"/> Monograph available             |
| <input type="checkbox"/> Invention remains confidential    | <input type="checkbox"/> Inventor technology             |
| <input type="checkbox"/> champion                          | <input type="checkbox"/>                                 |
| <input type="checkbox"/> No publications pending           | <input checked="" type="checkbox"/> Inventor team player |
| <input type="checkbox"/> No prior claims to the technology | <input type="checkbox"/> Industrial partner identified   |

**5. LIST OF EQUIPMENT BOUGHT USING THIS VOT**

Attachment \_\_\_\_\_

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**6. STATEMENT OF ACCOUNT**

a)	APPROVED FUNDING	RM : 456,000,00
b)	TOTAL SPENDING	RM : .....
c)	BALANCE	RM : .....

**7. TECHNICAL DESCRIPTION AND PERSPECTIVE**

*Please tick an executive summary of the new technology product, process, etc., describing how it works. Include brief analysis that compares it with competitive technology and signals the one that it may replace. Identify potential technology user group and the strategic means for exploitation.*

## a) Technology Description

The project provides new test rigs for internal combustion engine study. Instrumentations were installed and thus provide a useful facility to the measurement of the engines. Data obtained were then used for further analysis to improve the efficiency and development of new components

## b) Market Potential

The car industries are developing well in this region. Designing new components, which are more economical and better performance are essential to compete in this growing market. This project had successfully produced a new component of pump impeller and water cooling system data to support the development of car components making industries in Malaysian.

c) Commercialisation Strategies

The prototype is still under testing and the right choice of material is also yet to be decided. The governing equations for the developed design have to be patented for future use in the prototype design for other working conditions. A few companies have shown interest to manufacture the products but they need to get contract as the vendor to supply the components. Otherwise, this product can be manufactured ourself abd to be installed in our own designed engines. The products have improve the performance and save the fuel consumption of the I.C. engine.

**8. RESEARCH PERFORMANCE EVALUATION**

a) FACULTY RESEARCH COORDINATOR

Research Status	( )	( )	( )	( )	( )	( )
Spending	( )	( )	( )	( )	( )	( )
Overall Status	( )	( )	( )	( )	( )	( )
	Excellent	Very Good	Good	Satisfactory	Fair	Weak

Comment/Recommendations :

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b) RMC EVALUATION

Research Status	( )	( )	( )	( )	( )	( )
Spending	( )	( )	( )	( )	( )	( )
Overall Status	( )	( )	( )	( )	( )	( )
	Excellent	Very Good	Good	Satisfactory	Fair	Weak

Comments :-

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Recommendations :

Needs further research

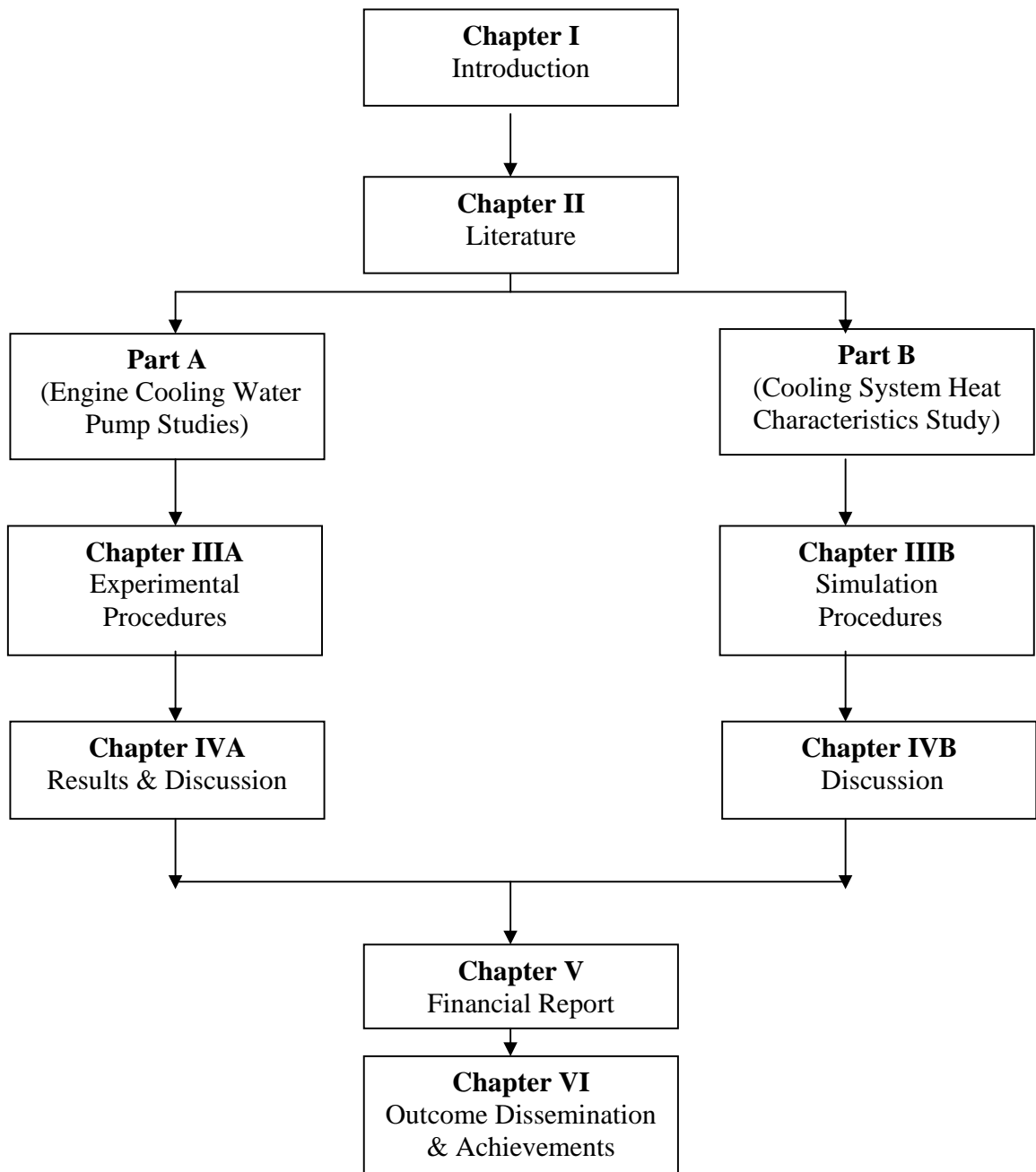
Patent application recommended

Market without patent

No tangible product. Report to be filed as reference







**Report Chapters Flow Charts**

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## **DESIGN AND DEVELOPMENT OF PUMPS FOR USE IN POWER PLANTS AND CARS**

*(Keywords : Energy, Automotive Component, Cooling System, Machinery and Equipment)*

### **ABSTRACT**

The development of the automobile industry in Malaysia has been very encouraging in the past years. Anyhow, this industry is confined to technology follower rather than technology leader. Thus the purpose of the project is to contribute positively to the whole process of automotive development in Malaysia. The advancement of automobile has continuously demanded more engine power requirement and thus, has increased the thermal load of the cooling system. In response to this, concern has been given to the cooling system efficiency improvement. To understand the effects of cooling system on the performance of the engine, the heat characteristics of cooling system were studied with different cooling temperatures. This range of temperatures, results in variations of engine performance, particularly the engine emission level. Engine hydrocarbon emissions increased as the coolant temperature decreases and therefore the importance of coolant temperature on the engine performance could not be neglected.

As for the cooling system study, new cooling pump impellers have been designed. Series of experiments were carried out to determine the performance of the impellers as part of a water pump and also its influence to the engine performance. The new impellers produced 17% increase in the water pump efficiency. Since cooling water pump is operated by the engine itself, the efficiency improvement will therefore increase the engine efficiency by 6% or approximately 0.85kW in power gain for a 1.5 litre engine.

Manufacturing study was also carried out to ensure the cost of the new impellers is within the marketing value, thus to improve its demand over conventional impeller.

### **Key Researchers :**

Prof. Ir. Dr. Alias bin Mohd. Noor  
Dr. Rosli bin Abu Bakar  
Srithar a/l Rajoo  
Mardani Ali Sera

E-mail : [alias@fkm.utm.my](mailto:alias@fkm.utm.my)  
Tel. No. : 607-553 4567  
Fax No. : 607-556 6159



**REKABENTUK DAN PEMBANGUNAN PAM  
UNTUK KEGUNAAN LOJI KUASA DAN KERETA**

*(Katakunci : Tenaga, komponen Automotif, Sistem Penyejukan, Peralatan dan Mesin)*

**ABSTRAK**

Pembangunan industri automobil pada kebelakangan ini sangatlah menggalakkan. Walau bagaimanapun, industri ini hanya terkongkong sebagai pengikut atau meniru teknologi luar dan tidak sebagai pengasas atau pencipta teknologi baru. Dengan yang demikian, tujuan projek ini adalah untuk memberi sumbangan positif terhadap proses pembangunan automotif di Malaysia ini. Selari dengan kemajuan teknologi automobil, kuasa enjin yang lebih tinggi sentiasa diperlukan, dengan ini akan menaikkan beban haba terhadap sistem penyejukan. Lanjutan dari ini, penekanan telah diberikan terhadap memperbaiki kecekapan sistem penyejukan. Untuk memahami kesan sistem penyejukan terhadap prestasi enjin, ciri-ciri haba untuk sistem penyejukan dikaji dengan beberapa suhu penyejukan. Perubahan terhadap suhu penyejukan didapati memberi kesan terhadap prestasi enjin, terutama sekali paras emisi enjin. Emisi hidrokarbon enjin bertambah apabila suhu penyejukan rendah dan dengan ini kepentingan suhu penyejukan terhadap prestasi enjin tidak boleh diabaikan.

Dalam kajian sistem penyejukan, beberapa bilah pendesak pam telah direkabentuk. Beberapa ujikaji telah dilakukan untuk mengenalpasti prestasi pendesak sebagai sebahagian dari pam air dan juga kesan terhadap prestasi enjin. Pendesak baru telah menghasilkan 17% kenaikan kecekapan pam. Oleh kerana pam penyejukan ini juga digerakkan oleh kuasa dari enjin, maka kecekapan enjin juga akan didapati bertambah baik, iaitu kenaikan kecekapan enjin sehingga 6% atau lebih kurang 0.85 kW keuntungan kuasa untuk enjin 1.5 litre.

Kajian terhadap pembuatan dan pengeluaran komponen ini juga dilakukan untuk memastikan kos pendesak baru adalah pada nilai yang boleh dipasarkan, dengan demikian akan menjadi lebih menarik dari pendesak yang sedia ada.

**Penyelidik Utama :**

Prof. Ir. Dr. Alias bin Mohd. Noor  
Dr. Rosli bin Abu Bakar  
Srithar a/l Rajoo  
Mardani Ali Sera

E-mail : [alias@fkm.utm.my](mailto:alias@fkm.utm.my)  
Tel. No. : 607-553 4567  
Fax No. : 607-556 6159



## 5.1 List of Equipments

- 1) Computer (Intel Pentium II 333 MMX, Serial No.E809007279) plus printer BJC 255SP
- 2) Car Engine (Proton Saga Mega Valve, 1500 cc, Serial No. G15RNB8965)
- 3) Hand held Tachometer
- 4) Inverter (Motor Controller)
- 5) Flow and Level Control
- 6) Motor 3-Phase
- 7) A-2, 12' Pulley
- 8) External Modem Artnet
- 9) Computer (Data Vox BX PIII450 plus BJC620 Printer)
- 10) Elora Tool Box and Tool Assortment
- 11) Watt-Meter Display
- 12) ATX Power Supply
- 13) Techometer with Magnetic Pick Up, Temperature Indicator, Thermocouple Charge Over switch, Shaft Seal and cable
- 14) 2 units Thermocouple Scanner
- 15) RS Flow Sensor Dual Range Digital Pressure Sensor with LED Bar Display
- 16) ONO-SOKI Torque Detector
- 17) 3 phase high speed motor 1 HP
- 18) Exhausting Fan
- 19) Radiator
- 20) Combustion Engine Pressure Sensor with cable and water cooling

- 21) 1 set of Crank Angle Encoder 2612C
- 22) KISTLER Thermocouple Module Model : PAD-TH8, 8-Channel, K-type
- 23) DAQ 1-Channel Charge Module Model : DAQ 5040
- 24) Hydraulic SAJ Dynamometer with Remote Load Control System, Carden Shaft, Calibration Tools and Dynamometer & Universal Engine Test Frame
- 25) 2 unit DAQ Module for Angle Encoder Model : DAQN-V-BNC
- 26) LABTECH 48 Channel 20 khz, 12 bit A/D
- 27) N.I Extrusion Cable and Accessories including Installation, Commissioning and Testing
- 28) DEWERACK 16 Channel Rack Housing
- 29) VSC 152T CHP water pump
- 30) Inoxa Pump and Acrylic
- 31) 1 unit of HP Laser Printer - Model 1200
- 32) 1 unit of Canon Scanner - Model N640P
- 33) Used 1,600cc Mitsubishi Petrol Engine, twin cam type cum with turbo Model (No.: 4G-61-HE5433)
- 34) 2 units of Piezoresistive Absolute Pressure Sensor M12x1.20...120 deg C Range : 10 bar with 2 units of Cooling Adapter, 2 units Connecting Cable and 2 units Piezoresistive Amplifier for pressure sensor

## **Benefits Report Guidelines**

### **A. Purpose**

The purpose of the Benefits Report is to allow the IRPA Panels and their supporting experts to assess the benefits derived from IRPA-funded research projects.

### **B. Information Required**

The Project Leader is required to provide information on the results of the research project, specifically in the following areas:

- Direct outputs of the project;
- Organisational outcomes of the project; and
- Sectoral/national impacts of the project.

### **C. Responsibility**

The Benefits Report should be completed by the Project Leader of the IRPA-funded project.

### **D. Timing**

The Benefits Report is to be completed within three months of notification by the IRPA Secretariat. Only IRPA-funded projects identified by MPKSN are subject to this review. Generally, the Secretariat will notify Project Leaders of selected projects within 18 months of project completion.

### **E. Submission Procedure**

One copy of this report is to be mailed to :

IRPA Secretariat  
Ministry of Science, Technology and the Environment  
14<sup>th</sup>, Floor, Wisma Sime Darby  
Jalan Raja Laut  
55662 Kuala Lumpur

## Benefit Report

### 1. Description of the Project

#### A. Project identification

1. Project number : 03-02-06-0114
2. Project title : Design And Development Of Pumps For Use In Power Plants and Cars
3. Project leader : Prof. Ir. Dr. Alias Bin Mohd. Noor

#### B. Type of research

Indicate the type of research of the project (Please see definitions in the Guidelines for completing the Application Form)

- Scientific research (fundamental research)
- Technology development (applied research)
- Product/process development (design and engineering)
- Social/policy research

#### C. Objectives of the project

##### 1. Socio-economic objectives

Which socio-economic objectives are addressed by the project? (Please identify the sector, SEO Category and SEO Group under which the project falls. Refer to the Malaysian R&D Classification System brochure for the SEO Group code)

Sector : Economic Development  
SEO Category : Energy  
SEO Group and Code : Machinery and Equipment (S20615)

##### 2. Fields of research

Which are the two main FOR Categories, FOR Groups, and FOR Areas of your project? (Please refer to the Malaysia R&D Classification System brochure for the FOR Group Code)

###### a. Primary field of research

FOR Category : Applied Sciences and Technologies (F10600)  
FOR Group and Code : Energy Industry (F10606)  
FOR Area : Transport and Other Energy Industries

###### b. Secondary field of research

FOR Category : Engineering Sciences  
FOR Group and Code : Mechanical and Industrial Engineering (F10701)  
FOR Area : Mechanical Engineering



**D. Project duration**

What was the duration of the project ?

\_\_\_\_\_36\_\_\_\_\_ Months

**E. Project manpower**

How many man-months did the project involve?

\_\_\_\_\_123\_\_\_\_\_ Man-months

**F. Project costs**

What were the total project expenses of the project?

RM 456,000

**G. Project funding**

Which were the funding sources for the project?

Funding sources

Total Allocation (RM)

IRPA \_\_\_\_\_

RM 456,000

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## II. Direct Outputs of the Project

### A. Technical contribution of the project

#### 1. What was the achieved direct output of the project :

For scientific (fundamental) research projects?

- Algorithm
- Structure
- Data
- Other, please specify : \_Governing Equation\_\_\_\_\_

For technology development (applied research) projects :

- Method/technique
- Demonstrator/prototype
- Other, please specify : \_Product Design\_\_\_\_\_

For product/process development (design and engineering) projects:

- Product/component
- Process
- Software
- Other, please specify : Improve performance and save fuel consumption of the Internal Combustion Engine

#### 2. How would you characterise the quality of this output?

- Significant breakthrough
- Major improvement
- Minor improvement

**B. Contribution of the project to knowledge**

**1. How has the output of the project been documented?**

- Detailed project report
- Product/process specification documents
- Other, please specify : \_\_\_\_\_

**2. Did the project create an intellectual property stock?**

- Patent obtained
- Patent pending
- Patent application will be filed
- Copyright

**3. What publications are available?**

- Articles (s) in scientific publications                      How Many: \_\_\_\_\_
- Papers(s) delivered at conferences/seminars                      How Many: 12
- Book
- Other, please specify : \_\_\_\_\_

**4. How significant are citations of the results?**

- Citations in national publications                      How Many: \_\_\_\_\_
- Citations in international publications                      How Many: \_\_\_\_\_
- None yet
- Not known

### III. Organisational Outcomes of the Project

#### A. Contribution of the project to expertise development

##### 1. How did the project contribute to expertise?

- PhD degrees How Many: \_\_\_\_\_
- MSc degrees How Many: 2 \_\_\_\_\_
- Research staff with new specialty How Many: 7 \_\_\_\_\_
- Other, please specify: \_\_\_\_\_

##### 2. How significant is this expertise?

- One of the key areas of priority for Malaysia
- An important area, but not a priority one

#### B. Economic contribution of the project?

##### 1. How has the economic contribution of the project materialised?

- Sales of manufactured product/equipment
- Royalties from licensing
- Cost savings
- Time savings
- Other, please specify : \_\_\_\_\_

##### 2. How important is this economic contribution ?

- High economic contribution Value: RM \_\_\_\_\_
- Medium economic contribution Value: RM \_\_\_\_\_
- Low economic contribution Value: RM \_\_\_\_\_

**3. When has this economic contribution materialised?**

- Already materialised
- Within months of project completion
- Within three years of project completion
- Expected in three years or more
- Unknown

**C Infrastructural contribution of the project**

**1. What infrastructural contribution has the project had?**

- New equipment Value: RM \_\_\_\_\_
- New/improved facility Investment : RM \_\_\_\_\_
- New information networks
- Other, please specify: \_\_Software\_\_\_\_\_

**2. How significant is this infrastructural contribution for the organisation?**

- Not significant/does not leverage other projects
- Moderately significant
- Very significant/significantly leverages other projects

**D. Contribution of the project to the organisation's reputation**

**1. How has the project contributed to increasing the reputation of the organisation**

- Recognition as a Centre of Excellence
- National award
- International award
- Demand for advisory services
- Invitations to give speeches on conferences
- Visits from other organisations
- Other, please specify: \_\_\_\_\_

**2. How important is the project's contribution to the organisation's reputation ?**

Not significant

Moderately significant

Very significant

#### IV. National Impacts of the Project

##### A. Contribution of the project to organisational linkages

###### 1. Which kinds of linkages did the project create?

Domestic industry linkages

International industry linkages

Linkages with domestic research institutions, universities

Linkages with international research institutions, universities

###### 2. What is the nature of the linkages?

Staff exchanges

Inter-organisational project team

Research contract with a commercial client

Informal consultation

Other, please specify: \_\_\_\_\_

##### B. Social-economic contribution of the project

###### 1. Who are the direct customer/beneficiaries of the project output?

Customers/beneficiaries:

\_\_\_\_\_ Car Industries \_\_\_\_\_

Number:

2 ( Proton, Perodua) \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

###### 2. How has/will the socio-economic contribution of the project materialised ?

Improvements in health

Improvements in safety

Improvements in the environment

Improvements in energy consumption/supply

Improvements in international relations

Other, please specify: \_\_\_\_\_

**3. How important is this socio-economic contribution?**

High social contribution

Medium social contribution

Low social contribution

**4. When has/will this social contribution materialised?**

Already materialised

Within three years of project completion

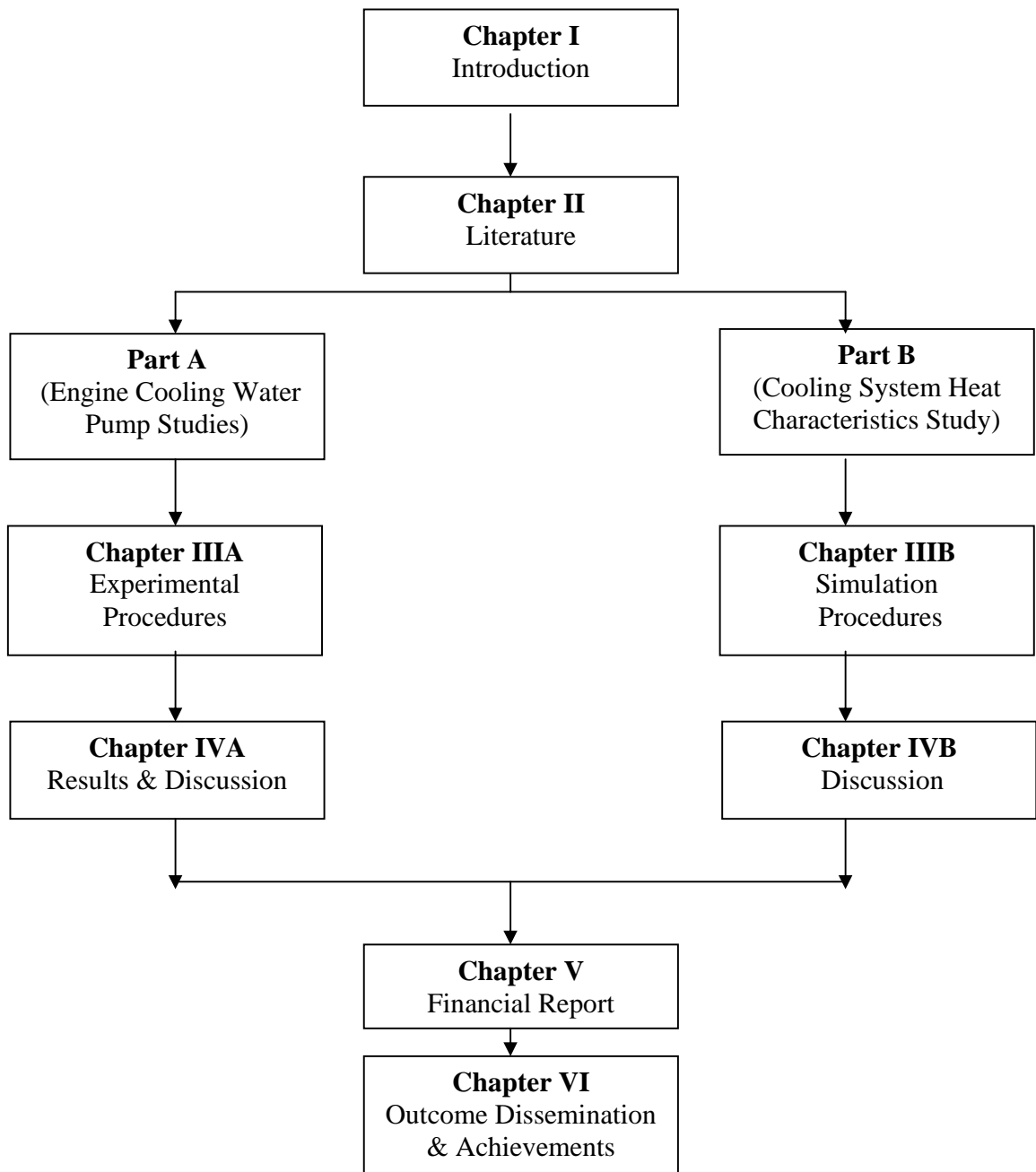
Expected in three years or more

Unknown

**Date: 30-06-2003**

**Signature:**





**Report Chapters Flow Charts**

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## **End of Project Report Guidelines**

### **A. Purpose**

The purpose of the End of Project is to allow the IRPA Panels and their supporting group of experts to assess the results of research projects and the technology transfer actions to be taken.

### **B. Information Required**

The following Information is required in the End of Project Report :

- Project summary for the Annual MPKSN Report;
- Extent of achievement of the original project objectives;
- Technology transfer and commercialisation approach;
- Benefits of the project, particularly project outputs and organisational outcomes; and
- Assessment of the project team, research approach, project schedule and project costs.

### **C. Responsibility**

The End of Project Report should be completed by the Project Leader of the IRPA-funded project.

### **D. Timing**

The End of Project Report should be submitted within three months of the completion of the research project.

### **E. Submission Procedure**

One copy of the End of Project is to be mailed to :

IRPA Secretariat  
Ministry of Science, Technology and the Environment  
14<sup>th</sup> Floor, Wisma Sime Darby  
Jalan Raja Laut  
55662 Kuala Lumpur

## End of Project Report

**A. Project number : 03-02-06-0114**

**Project title : Design and Development of Pumps for use in Power Plants and Cars**

**Project leader: Prof. Ir. Dr. Alias Mohd. Noor**

**Tel: 07-5534567**

**Fax: 07-5566159**

**B. Summary for the MPKSN Report** (for publication in the Annual MPKSN Report, please summarise the project objectives, significant results achieved, research approach and team structure)

The development of the automobile industry in Malaysia has been very encouraging in the past years. Anyhow, this industry is confined to technology follower rather than technology leader. Thus the purpose of the project is to contribute positively to the whole process of automotive development in Malaysia. The advancement of automobile has continuously demanded more engine power requirement and thus, has increased the thermal load of the cooling system. In response to this, concern has been given to the cooling system efficiency improvement. To understand the effects of cooling system on the performance of the engine, the heat characteristics of cooling system were studied with different cooling temperatures. This range of temperatures, results in variations of engine performance, particularly the engine emission level. Engine hydrocarbon emissions increased as the coolant temperature decreases and therefore the importance of coolant temperature on the engine performance could not be neglected.

As for the cooling system study, new cooling pump impellers have been designed. Series of experiments were carried out to determine the performance of the impellers as part of a water pump and also its influence to the engine performance. The new impellers produced 17% increase in the water pump efficiency. Since cooling water pump is operated by the engine itself, the efficiency improvement will therefore increase the engine efficiency by 6% or approximately 0.85kW in power gain for a 1.5 litre engine.

Manufacturing study was also carried out to ensure the cost of the new impellers is within the marketing value, thus to improve its demand over conventional impeller.

**C. Objectives achievement**

- **Original project objectives** (Please state the specific project objectives as described in Section II of the Application Form)

- (i) To Design and develop indigenous Design of Pumps for use in power Plants and Cars.
- (ii) To Develop the techniques for improving designs by experimental research.
- (iii) To Design and develop special instruments for experimental development of Pumps.

- **Objectives Achieved** (Please state the extent to which the project objectives were achieved)

- (i) The main achievement is on the design of new impeller for pump used in engine cooling system.
- (ii) The test rig with instrumentation for further study-on engine performance, cooling system and emission.

- **Objectives not achieved** (Please identify the objectives that were not achieved and give reasons)

To set up a rig and to investigate industrial pumps at wide range of operating points, thus to study the cavitations phenomenon.

**D. Technology Transfer/Commercialisation Approach** (Please describe the approach planned to transfer/commercialise the results of the project)

The product from this research has improved the performance of the internal combustion engines. The design of new impeller for water pump-cooling system and the know-how of heat capacity developed through the combustion of fuel in the combustion chamber can lead to the design on the new system of cooling system of the engines.

Study on most economical manufacturing and choosing the right materials are still under investigations. It is our hope that the technology transfer through this will lead us to the design of more powerful engines such as turbocharged engines which the cooling system is the most critical factor to be considered.

**E. Benefits of the Project** (Please identify the actual benefits arising from the project as defined in Section III of the Application Form. For examples of outputs, organisational outcomes and sectoral/national impacts, please refer to Section III of the Guidelines for the Application of R&D Funding under IRPA)

- **Outputs of the project and potential beneficiaries** (Please describe as specifically as possible the outputs achieved and provide an assessment of their significance to users)

- The immediate application of the product is the new pump impeller, which can replace the existing one found in most local made cars and it has great capability to be marketed.
- Potential beneficiaries are automotive industries and pumps manufacturer.

- **Organisational Outcomes** (Please describe as specifically as possible the organisational benefits arising from the project and provide an assessment of their significance)

- Organisational outcomes are knowledge, expertise, test rigs for further works and recognition from industries. Through expo and exhibition this group has been recognized by various organizations.
- The center of excellence can be actively executed through these research activities and thus more developments on the knowledge of the internal combustion engines.

- **National Impacts** (If known at this point in time, please describes specifically as possible the potential sectoral/national benefits arising from the project and provide an assessment of their significance)

- The potential sector is our national automotive manufacturer or other vendors in car components industries.
- The industries that would involve and gain from this design will be automotive and turbo machines industries. Since automotive sector is improving drastically in Malaysia, this design will serve as a catalyst and further enhance our capability, especially in the engine cooling system. Nevertheless the indirect beneficiary of this design will the common people as they can obtain better value for their money.

**F. Assessment of project structure**

**Project Team** (Please provide an assessment of how the project team performed and highlight any significant departures from plan in either structure or actual man-days utilised)

Initially the project team consists of five lecturers and one student but after one year only two lecturers and two research officers were involved. At later stage three lecturers and two postgraduates were actively involved until the project successfully done. The lack of interest and commitment are the main reasons for the withdrawal of other lecturers.

- **Collaborations** (Please describe the nature of collaborations with other research organisations and/or industry)

There is no specific collaborations but there are small industries involved in the support to produce the specimens of the project. There is also one small industry interested to manufacture the products if they won the vendor tender of components supplier.

**G. Assessment of Research Approach** (Please highlight the main steps actually performed and indicate any major departure from the planned approach or any major difficulty encountered)

- (i) Study on the existing performance of the pumps and engines through visits,
- (ii) Literature survey,
- (iii) Experimental analysis and modification of the test rig.,
- (iv) Theoretical and Design analysis,
- (v) Design and Fabrication, Model analysis,
- (vi) Testing and product prototype,
- (vii) Major difficulty is to select the right material.

**H. Assessment of the Project Schedule** (Please make any relevant comment regarding the actual duration of the project and highlight any significant variation from plan)

The project schedules, which suppose to start in early 1998, only can be implemented one year later due to funding availability. Only in the early 1999, the project started by purchasing some of the experimental equipments and the modification of the test rigs. To get the dedicated researchers are also the main problems, not many can last longer until two post-graduate students gave their full commitment in realizing the experimental works, analysing the results and making the prototype. The project was actively carried out between early 1999 to late 2002. At late 2002 and early 2003, the prototypes were exhibited at two exhibitions, one is in national level where we won bronze medal and the second one at international level where we improved on economic aspect and we won silver medal. Therefore the actual duration is 4-year project.

<p><b>I. Assessment of Project Costs</b> (Please comment on the appropriateness of the original budget and highlight any major departure from the planned budget)</p> <p>The budget allocate is sufficient. Most of the budget are in purchasing the equipments and the payment of allowances to the researchers, but this is essentials. To get a good researcher is the main problem and therefore the costs for researchers allowances should be justified. The visits at various industries are also important to get the latest development of the product. At the end of the project by mid 2003, the amount spent is RM446,850.60 from the budget allocate at RM 456,000.</p>	
<p><b>J. Additional Project Funding Obtained</b> (In case of involvement of other funding sources)</p> <p>- NONE -</p>	
<p><b>K. Other Remarks</b> (Please include any other comment which you feel is relevant for the evaluation of this project)</p> <ul style="list-style-type: none"><li>- This project has successfully fabricated a new impeller for used in water pump of cooling system of internal combustion engine. The designs had been recognised for its performance from two exhibitions<ul style="list-style-type: none"><li>(i) Expo Science &amp; Technology 2002 (National) - won Bronze medal.</li><li>(ii) I.TEX 2003 (International) – won Silver medal.</li></ul></li><li>- The project also lead to the setting up of engine test bed for further study on the cooling system of internal combustion engines.</li></ul>	
<p><b>Date :</b></p>	<p><b>Signature :</b></p>







