

JH Major Project Proposal

by James Howe

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RAM milling for particle size reduction of a powdered oxidiser – method development and evaluation

Research Proposal

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1. Introduction

This project aims to outline a set of experiments that will allow the particle size reduction of Ammonium Perchlorate (AP) powder. Said experiments will describe a milling method using a Resonant Acoustic Mixer (RAM) and the analysis of the data produced aims to determine the relationships between the RAM's configurable parameters and the final particle size.



Up to 90% of a solid rocket composite propellant formulation is occupied by solid ingredients such as the oxidiser (AP). The level of particle packing is vital to producing high solid loadings in these formulations and is achieved through a bimodal or tri-modal distribution of particle sizes. Decreasing the AP's particle size increases the viscosity of the propellant and its burn rate which can directly lead to more thrust in a rocket motor [1], a key ballistic property.



The configurable RAM parameters are:

- The number of milling media
- RAM acceleration level
- Milling run-time
- Quantity of AP in the vessel (batch size)



The 6 month project has an ultimate aim to effectively produce AP with a mean particle size of 20 micrometres $\pm 10\%$.

Objectives:

- Develop a safe system of work (SSoW) with Risk Assessments (RAs) and Standard Operating Procedures (SOPs) to allow the research work to be completed safely
- Design and conduct a range of milling experiments to understand how RAM milling can be used to produce AP at a specified particle size and batch size
- Use multiple particle size analysis techniques to determine the particle size of the AP. This includes using a Malvern Mastersizer particle sizer and an optical microscope
- Be able to decrease the particle size to a desired value with a $\pm 10\%$ tolerance

2. Background to the Proposed Research

There are multiple methods of milling and each have their own advantages and disadvantages.

2.1 Air Classifiers

PPS Air Classifier Mill - How It Works

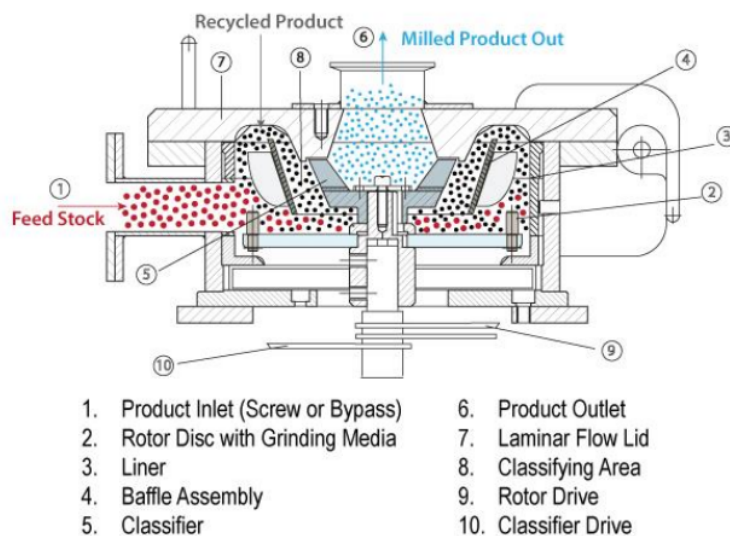


Figure 1 - Air Classifier Mill [2]

One study investigates the effect of milled AP on the particle shape and the viscosity of a propellant formulation [1]. Each batch analysed used an air classifying mill to generate a variety of particle sizes.  5

The desired particle size is set using a classifier and compressed air is used to recirculate any material back to the input feed that the classifier rejects. Centrifugal force is harnessed to cause the material to collide with other particles and the walls which causes the comminution (milling) effect.

all figures and tables must be mentioned in the text. sentences like 'as shown in Fig...' or 'as listed in Table...' are necessary when images or tables are included

2.2 Pin Mills

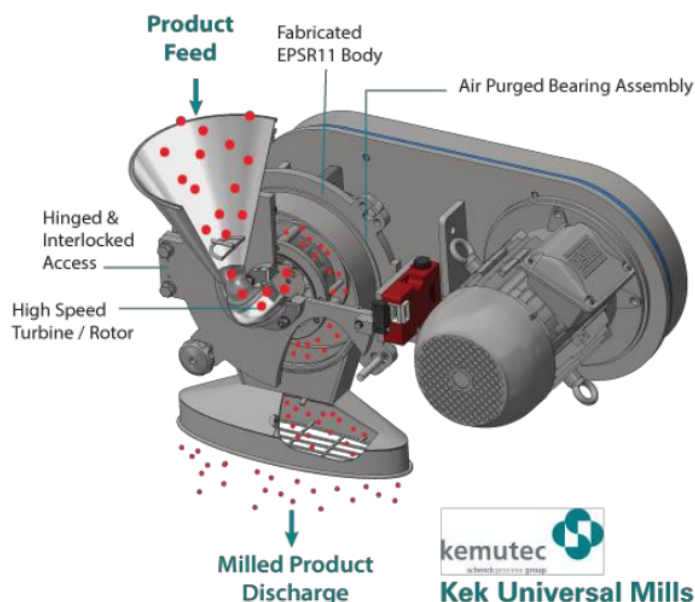


Figure 2 - Pin Mill [3]

Comminution occurs in pin mills when metal pins repeatedly pass each other in close proximity which can lead to particle sizes down to a few micrometres [4]. They are easy to set up and operate and are often used in the pharmaceutical industry however only a small amount of material can be processed. Another benefit is they possess the ability to be constantly fed material and do not rely on batch processing.

However, this method carries an additional risk of ignition from the pins creating metal on metal contact which could cause sparking. AP is considered to be a 1.1D explosive [5] when below 20 micrometres [6] and subsequently milling using this method would pose a mass explosion hazard.

2.3 Micronizers

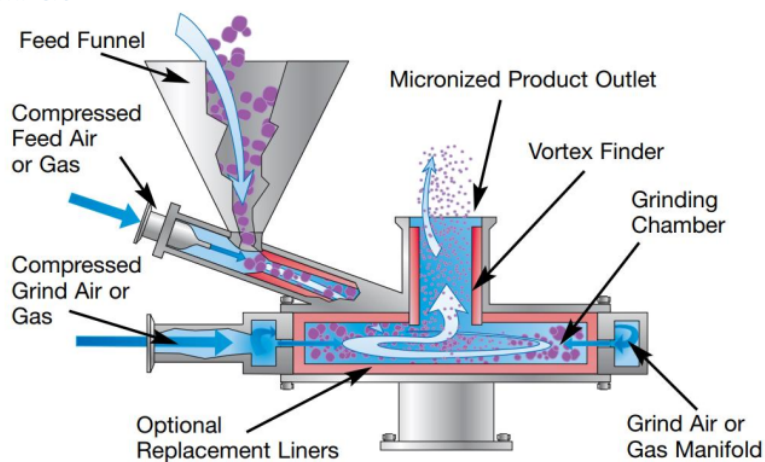


Figure 3 - Micronizer Air Mill [7]

Micronizers use compressed air to form a jet mill that can achieve ultra-fine particle sizes. The air vortex causes the comminution effect as the material collides with itself [8]. The Micronizer can run as a continuous process similarly to the pin mill.

They are however expensive to run due to requiring large amounts of electricity [9] and dry, oil-free compressed air [10] which presents both a high initial setup and long term running cost.

2.4 RAM Milling



Figure 4 - TFP Milling Vessel, Cage and a Resodyn LabRAM II

The Falcon Project (TFP) have designed a milling vessel configuration using ceramic and polyether ether ketone (PEEK) internal components which provides a reduced risk of ignition when compared to the metal contact in the pin mill. TFP have been able to show that RAM milling is a reproducible

method of comminution however, they have described limitations in the understanding of the process parameters and how altering them may affect the final particle size.

The RAM technology determines the combined resonant frequency of all of the components on top of the mounting plate. At this frequency, the TFP milling vessel vertically oscillates with a set force and allows the powder to flow well through the system which increases the consistency of the time spent in contact with the milling media or the cage. The milling media applies force to the AP particles and breaks down agglomerations.

4. Experimental Design

AP will be milled using a vessel on a RAM to decrease the particle size from 200 micrometres down to a desired size, the smallest being 20 micrometres, within a $\pm 10\%$ tolerance.

4.1 Outline of Experimental Procedure

A “branch of applied statistics that deals with planning, conducting, analysing and interpreting controlled tests” called Design of Experiments (DoE) [11] will be used to evaluate how the parameters control the output.

Using this the number of experiments required can be reduced as multiple milling parameters and variable relationships can be explored at the same time.

4.2 Data Collection

Particle size analysis will be conducted using both a microscope and a particle size analyser on samples that will be taken multiple times throughout a milling run. Small Scale Hazard Testing (SSHT) may also be conducted which will generate data on the hazard classification of the samples.

4.3 Data Evaluation

Microsoft Excel will be used to transform tabulated data into a more readable particle size against time graph. The formula for the best fit line on this graph can be used to predict the results of a run time that sits in-between the recorded results. Comparison against other milling methods can be drawn by working out the particle size distribution using the standard deviation and a bell curve diagram.

6. Resources & Planning

6.1 Resources Required

- Energetics processing facility with remote control functionality

6.1.1 Physical Resources

- 200 micrometre AP starting material
- TFP milling vessel, base plate and milling media
- Safety glasses, nitrile gloves, Nomex overalls
- Precision balance
- RAM operating consumables

6.1.2 Human Resources

- A minimum of two staff present
- A mentor
- Up to two trainees

6.2 Gantt Chart

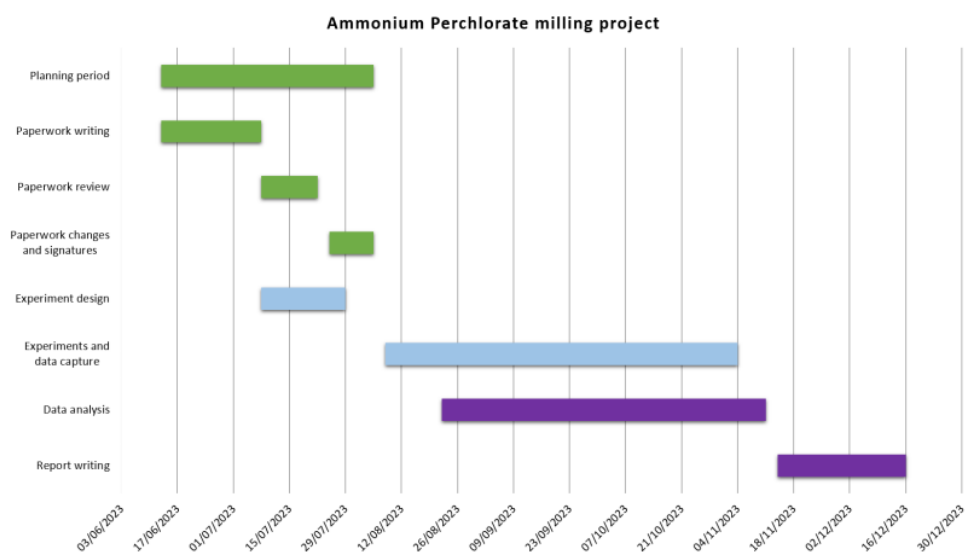


Figure 5 - AP Milling Project Gantt Chart

Task Name	Start (Date)	End (Date)	Duration (Days)
Planning period	13/06/2023	05/08/2023	53
Paperwork writing	13/06/2023	08/07/2023	25
Paperwork review	08/07/2023	22/07/2023	14
Paperwork changes and signatures	25/07/2023	05/08/2023	11
Experiment design	08/07/2023	29/07/2023	21
Experiments and data capture	08/08/2023	04/11/2023	88
Data analysis	22/08/2023	11/11/2023	81
Report writing	14/11/2023	16/12/2023	32

Table 1 - Gantt Chart Data

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- [8] N. Midoux, "Micronization of pharmaceutical substances in a spiral jet mill," *Powder Technology*, vol. CIV, no. 2, pp. 113-120, 1999.
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PTS 800 oil-free diesel driven compact air compressor - <https://www.atlascopco.com/en-uk/rental/products/air-rental/oil-free-air-compressors/diesel-driven/pts-800>

Impact of milling time and method on particle size and surface morphology during nano particle synthesis from α -Al₂O₃ - Nabnit Panigrahi , Rajeswari Chaini - Materials Processing and characterization, 16th – 18th March 2018 - Volume 5, Issue 9, Part 3, 2018, Pages 20727-20735

Standardizing milling process parameters for the narrowest pigment particle size distribution with optimum energy consumption - Shilpa Anchawale – Journal of Print and Media Technology Research – 31st December 2020 – Volume 9

9. Ethics Form

APPLICATION FOR ETHICAL APPROVAL

In order for research to result in benefit and minimise risk of harm, it must be conducted ethically.

The University follows the OECD Frascati manual definition of **research activity**: “creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications”. As such this covers activities undertaken by members of staff, postgraduate research students, and both taught postgraduate and undergraduate students working on dissertations/projects.

The individual undertaking the research activity is known as the “principal researcher”.

This form must be completed and approved prior to undertaking any research activity.

SECTION A: About You (Principal Researcher)

1	Full Name:	James Howe
2	Student Number:	1910319
3	Email address:	1910319@student.uwtsd.ac.uk
4	Programme of Study:	Bachelor of Science: Ordnance, Munitions & Explosives
5	Director of Studies/Supervisor:	Dave Holley

SECTION B: Internal and External Ethical Guidance Materials

Please list the core ethical guidance documents that have been referred to during the completion of this form (including any discipline-specific codes of research ethics, location-specific codes of research ethics, and also any specific ethical guidance relating to the proposed methodology). Please tick to confirm that your research proposal adheres to these codes and guidelines. You may add rows to this table if needed.		
1	<u>UWTSd Research Ethics & Integrity Code of Practice</u>	☒
2	<u>UWTSd Research Data Management Policy</u>	☒

3		☐
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SECTION C: Details of Research Activity

1	Indicative title:	RAM milling for particle size reduction of a powdered oxidiser – method development and evaluation.		
2	Proposed start date:	13/06/2023	Proposed end date:	16/12/2023
Introduction to the Research (maximum 300 words in each section) Ensure that you write for a Non-Specialist Audience when outlining your response to the three points below: • <i>Purpose of Research Activity</i> • <i>Proposed Research Question</i> • <i>Aims of Research Activity</i> • <i>Objectives of Research Activity</i> Demonstrate, briefly, how Existing Research has informed the proposed activity and explain • <i>What the research activity will add to the body of knowledge</i> • <i>How it addresses an area of importance.</i>				
3	Purpose of Research Activity To develop a method that allows the consistent reduction of particle size using Resonant Acoustic Mixing technology with a milling vessel. (this box should expand as you type)			
4	Research Question RAM milling for particle size reduction of a powdered oxidiser – method development and evaluation. (this box should expand as you type)			
5	Aims of Research Activity This project aims to develop a method using a milling vessel on a Resonant Acoustic Mixer and analyse its effectiveness in producing AP with a mean particle size of 20 micron $\pm 10\%$ within a 6 month project. As discussed, the ability to decrease the particle size allows the configuration			

	of burn rate and in turn the thrust characteristics within a rocket motor using a solid composite propellant. (this box should expand as you type)
6	Objectives of Research Activity • Develop a safe system of work (SSoW) with Risk Assessments (RAs) and Standard Operating Procedures (SOPs) to allow completion of research work safely. • Design and conduct a range of milling experiments to understand how RAM milling can be used to produce AP at a specified batch size and particle size. • Use multiple particle size analysis techniques to determine process AP particle size. This includes using a Malvern Mastersizer particle sizer and optical microscope. • Be able to decrease the particle size to a desired value with a $\pm 10\%$ tolerance. (this box should expand as you type)
	Proposed data collection methods (maximum 600 words) Provide a brief summary of all the methods that may be used in the research activity to collect data, making it clear what specific techniques may be used. If methods other than those listed in this section are deemed appropriate later, additional ethical approval for those methods will be needed. You do not need to justify the methods here, but should instead describe how you intend to collect the data necessary for you to complete your project.
7	Particle size analysis will be conducted using a particle sizer and a microscope. (this box should expand as you type)

SECTION D: Scope of Research Activity

	Will the research activity include:	YES	NO
1	Use of a questionnaire or similar research instrument?	☐	☒
2	Use of interviews?	☐	☒
3	Use of focus groups?	☐	☒
4	Use of participant diaries?	☐	☒

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5	Use of video or audio recording?	☐	☒
6	Use of computer-generated log files?	☐	☒
7	Participant observation with their knowledge?	☐	☒
8	Participant observation without their knowledge?	☐	☒
9	Access to personal or confidential information without the participants' specific consent?	☐	☒
10	Administration of any questions, test stimuli, presentation that may be experienced as physically, mentally or emotionally harmful / offensive?	☐	☒
11	Performance of any acts which may cause embarrassment or affect self-esteem?	☐	☒
12	Investigation of participants involved in illegal activities?	☐	☒
13	Use of procedures that involve deception?	☐	☒
14	Administration of any substance, agent or placebo?	☐	☒
15	Working with live vertebrate animals?	☐	☒
16	Procedures that may have a negative impact on the environment?	☐	☒
17	Other primary data collection methods. Please indicate the type of data collection method(s) below.		
	Details of any other primary data collection method:	☐	☐
	(this box should expand as you type)		

If you have ticked NO to every question then the research activity is (ethically) low risk and you may skip section E and continue to section F.

If YES to any question, then no research activity should be undertaken until full ethical approval has been obtained.

SECTION E: Intended Participants

Who are the intended participants:	YES	NO
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1	Students or staff at the University?	☐	☐
2	Adults (over the age of 18 and competent to give consent)?	☐	☐
3	Vulnerable adults?	☐	☐
4	Children and Young People under the age of 18? (Consent from Parent, Carer or Guardian will be required)	☐	☐
5	Prisoners?	☐	☐
6	Young offenders?	☐	☐
7	Those who could be considered to have a particularly dependent relationship with the investigator or a gatekeeper?	☐	☐
8	People engaged in illegal activities?	☐	☐
9	Others. Please indicate the participants below, and specifically any group who may be unable to give consent.		
	Details of any other participant groups: Complete this only if your participants cannot give consent. This includes animals (this box should expand as you type)	☐	☐

Participant numbers and source Provide an estimate of the expected number of participants. How will you identify participants and how will they be recruited?		
10	How many participants are expected?	Ballpark figures are fine, but make sure that you explain how you will identify and contact your participants. (this box should expand as you type)
11	Who will the participants be?	(this box should expand as you type)
12	How will you identify the participants?	

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		(this box should expand as you type)
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	Information for participants:	YES	NO	N/A
13	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	☐	☐	☐
14	Will you tell participants that their participation is voluntary?	☐	☐	☐
15	Will you obtain written consent for participation?	☐	☐	☐
16	Will you explain to participants that refusal to participate in the research will not affect their treatment or education (if relevant)?	☐	☐	☐
17	If the research is observational, will you ask participants for their consent to being observed?	☐	☐	☐
18	Will you tell participants that they may withdraw from the research at any time and for any reason?	☐	☐	☐
19	With questionnaires, will you give participants the option of omitting questions they do not want to answer?	☐	☐	☐
20	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☐	☐	☐
21	Will you debrief participants at the end of their participation, in a way appropriate to the type of research undertaken?	☐	☐	☐
22	If NO to any of above questions, please give an explanation			
	You should be able to tick YES for all of these questions. If not, then explain why not in this box. (this box should expand as you type)			

	Information for participants:	YES	NO	N/A
24	Will participants be paid?	☐	☐	☐
25	Is specialist electrical or other equipment to be used with participants?	☐	☐	☐
26	Are there any financial or other interests to the investigator or University arising from this study?	☐	☐	☐

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27	Will the research activity involve deliberately misleading participants in any way, or the partial or full concealment of the specific study aims?	☐	☐	☐
28	If YES to any question, please provide full details			
	You should be able to tick NO for most of these questions. For any cases that you have ticked YES then provide details in this box. If you are using cameras/voice recorders to record interviews then please state that in this box. <i>(this box should expand as you type)</i>			

SECTION F: Anticipated Risks

	Outline any anticipated risks that may adversely affect any of the participants, the researchers and/or the University, and the steps that will be taken to address them.	
1	Risks to participants For example: sector-specific health & safety, emotional distress, financial disclosure, physical harm, transfer of personal data, sensitive organisational information. If you have identified in section D that there are no participants then enter N/A and go skip to question 3.	
	Risk to participants: Potential for harm when handling Ammonium Perchlorate from inhalation. <i>(this box should expand as you type)</i>	How you will mitigate the risk to participants: The exposure level is below work place limits and appropriate PPE will be worn such as nitrile gloves and face coverings. <i>(this box should expand as you type)</i>
2	If research activity may include sensitive, embarrassing or upsetting topics (e.g. sexual activity, drug use) or issues likely to disclose information requiring further action (e.g. criminal activity), give details of the procedures to deal with these issues, including any support/advice (e.g. helpline numbers) to be offered to participants. Note that where applicable, consent procedures should make it clear that if something potentially or actually illegal is discovered in the course of a project, it may need to be disclosed to the proper authorities	
	N/A <i>(this box should expand as you type)</i>	
3	Risks to the investigator	

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	For example: personal health & safety, physical harm, emotional distress, risk of accusation of harm/impropriety, conflict of interest	
	Risk to the investigator: Potential for harm when handling Ammonium Perchlorate from inhalation. <i>(this box should expand as you type)</i>	<i>How you will mitigate the risk to the investigator:</i> The exposure level is below work place limits and appropriate PPE will be worn such as nitrile gloves and face coverings. <i>(this box should expand as you type)</i>
4	University/institutional risks For example: adverse publicity, financial loss, data protection	
	Risk to the University: The work being conducted is tied to defence research and rocket motor technology. <i>(this box should expand as you type)</i>	<i>How you will mitigate the risk to the University:</i> The research is beneficial for both the host company and the progress of the investigators learning. <i>(this box should expand as you type)</i>
5	Environmental risks For example: accidental spillage of pollutants, damage to local ecosystems	
	Risk to the environment: N/A <i>(this box should expand as you type)</i>	<i>How you will mitigate the risk to environment:</i> <i>(this box should expand as you type)</i>

SECTION G: Feedback, Consent and Confidentiality

If you have identified in section D that there are no participants then enter skip this section and continue to section H.

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1	Feedback What de-briefing and feedback will be provided to participants, how will this be done and when?
	You don't need to email your participants with your final report. A good alternative is to set up an email address that they will be able to contact for further details or results. (this box should expand as you type)
2	Informed consent Describe the arrangements to inform potential participants, before providing consent, of what is involved in participating. Describe the arrangements for participants to provide full consent before data collection begins. If gaining consent in this way is inappropriate, explain how consent will be obtained and recorded in accordance with prevailing data protection legislation.
	If you are using a paper questionnaire then you should have the participants sign an appropriate consent form. These forms will count as personal data and should be noted as such in section J. If you are using an online questionnaire, then you should have a screen before the questions start that acts as a consent form, informing participants that by clicking on the NEXT button they are providing consent. (this box should expand as you type)
3	Confidentiality / Anonymity Set out how anonymity of participants and confidentiality will be ensured in any outputs. If anonymity is not being offered, explain why this is the case.
	Do not collect names unless you really need them. Do not name participants or organisations in any research publications (including the thesis) without their explicit permission. (this box should expand as you type)

SECTION H: Data Protection and Storage

	Does the research activity involve personal data (as defined by the General Data Protection Regulation 2016 "GDPR" and the Data Protection Act 2018 "DPA")?	YES	NO
1	"Personal data" means any information relating to an identified or identifiable natural person ('data subject'). An identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number,	☐	X

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	location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person. Any video or audio recordings of participants is considered to be personal data.		
	If YES, provide a description of the data and explain why this data needs to be collected:		
2	This includes audio/video data of participants, but can also include IP addresses and usernames. Names, addresses and emails also count, as do consent forms. (this box should expand as you type)		
	Does it involve special category data (as defined by the GDPR)?	YES	NO
3	“Special category data” means sensitive personal data consisting of information as to the data subjects’ – (a) racial or ethnic origin, (b) political opinions, (c) religious beliefs or other beliefs of a similar nature, (d) membership of a trade union (within the meaning of the Trade Union and Labour Relations (Consolidation) Act 1992), (e) physical or mental health or condition, (f) sexual life, (g) genetics, (h) biometric data (as used for ID purposes),	☐	☒
	If YES, provide a description of the special category data and explain why this data needs to be collected:		
4	What counts as ‘sensitive’ will differ between cultures. Any information on behaviour that is not in accordance with cultural norms would count as sensitive personal data. (this box should expand as you type)		

	Will data from the research activity (collected data, drafts of the thesis, or materials for publication) be stored in any of the following ways?	YES	NO
5	Manual files (i.e. in paper form)?	☐	☒
6	University computers?	☐	☒
7	Private company computers?	☒	☐
8	Home or other personal computers?	☐	☒
9	Laptop computers/ CDs/ Portable disk-drives/ memory sticks?	☐	☒
10	“Cloud” storage or websites?	☐	☒

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11	Other – specify:	☐	☒
12	For all stored data, explain the measures in place to ensure the security of the data collected, data confidentiality, including details of backup procedures, password protection, encryption, anonymisation and pseudonymisation:		
	If possible, save your data on computers that are secure and regularly backed up. Many cloud services only provide GDPR-compliant storage for business customers. An example of suitable text is given below. <i>All data will be kept in password protected cloud storage on the University Office 365 system which will not be shared. Audio/visual data will be transcribed and would be shown to participants to check accuracy of reporting. Any USB sticks used to store or transfer data will be password protected. All participants will be given a unique identifier to ensure confidentiality and this list will be kept securely in the password protected folder.</i> The private company's drives are regularly backed up and have a high level of security. <i>(this box should expand as you type)</i>		

Data Protection			
	Will the research activity involve any of the following activities:	YES	NO
13	Electronic transfer of data in any form?	☒	☐
14	Sharing of data with others at the University outside of the immediate research team?	☐	☒
15	Sharing of data with other organisations?	☐	☒
16	Export of data outside the UK or importing of data from outside the UK?	☐	☒
17	Use of personal addresses, postcodes, faxes, emails or telephone numbers?	☐	☒
18	Publication of data that might allow identification of individuals?	☐	☒
19	If YES to any question, please provide full details, explaining how this will be conducted in accordance with the GDPR and Data Protection Act (2018) (and/or any international equivalent):		

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	This includes data such as drafts of your thesis as well as experimental or survey data. An example of suitable text is given below. <i>All data will be encrypted and kept in password protected cloud storage on the University Office 365 system which will not be shared. Any USB sticks used to store or transfer data will be password protected. All data transfers will be encrypted and password protected. All participants will be given a unique identifier to ensure confidentiality and this list will be kept securely in the password protected folder. The data will be stored until the completion of the project and then deleted. In accordance with the DPA2018, participants will have the right to ask to see what data is held relating to them, and this data will be deleted immediately if the participant requests this, in which case the data will not be used in the project.</i> <i>(this box should expand as you type)</i>
20	List all who will have access to the data generated by the research activity: Normally the principal researcher, possibly also the supervisor and, if the project has an industrial partner, a representative of that partner. Possibly also external examiner or second marker? The principal researcher. Workplace supervisor/mentor. Other members of staff working on the project in the lab. <i>(this box should expand as you type)</i>
21	List who will have control of, and act as custodian(s) for, data generated by the research activity: Usually the principal researcher. The principal researcher and supervisor. <i>(this box should expand as you type)</i>
22	Give details of data storage arrangements, including security measures in place to protect the data, where data will be stored, how long for, and in what form. <i>All data will be encrypted and kept in password protected cloud storage on the University Office 365 system which will not be shared. Any USB sticks used to store or transfer data will be password protected, and will be reformatted at the end of the project in order to destroy the data. The data will be stored until the completion of the project and then deleted.</i> <i>(this box should expand as you type)</i>
22	Confirm that you have read the UWTSD guidance on data management (see https://www.uwt.ac.uk/library/research-data-management/) ☒

OFFICIAL

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23	Confirm that you are aware that you need to keep all data until after your research has completed or the end of your funding	☒
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SECTION I: Declaration

The information which I have provided is correct and complete to the best of my knowledge. I have attempted to identify any risks and issues related to the research activity and acknowledge my obligations and the rights of the participants. In submitting this application I hereby confirm that I undertake to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice which is published on the website: https://www.uwtsd.ac.uk/research/research-ethics/		
1	Signature of applicant:	Jhowe
2	Director of Studies/Supervisor:	Dave Holley
3	Signature:	

FOR INTERNAL USE ONLY:

Ethical approval given		
1	Signature of assessor:	Date:
2	Name:	
3	Role:	

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JH Major Project Proposal

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

64/100

Intro / Aim & Objectives (150 words) 272 Project		
<i>Project title. Identification of a specific problem to be investigated. Well-defined aims and SMART objectives.</i>	20	13
<i>Explaining why this project is worth doing. Discussion of what the project needs to do to be a success.</i>		
<i>Description of any deliverables that will be produced at the end of the project</i>		
The project title clearly describes the purpose of the proposed research		
The problem to be investigated and the justification for why it is necessary is both described in Introduction.		
The main aim of this project is well-defined but the objectives are not SMART	20	10
Deliverable outcome (particles with decreased size) is specified.		
This section is significantly over the recommended word count		
Background to the Project / Literature Review (450 words) 422		
<i>Description of how the work to be done in the project relates to the work identified in the literature review. Discussion of any ethical issues</i>	20	10

<i>raised by the project Identifying what has already been done within the field. Topic familiarity. Brief literature review using appropriate sources – 6-8 journal papers and book chapters rather than just websites. Selection of relevant models & concepts.</i> Three different methods of milling (besides RAM) are presented and their advantages/disadvantages are described but there is no clear connection to the experimental approach offered in this project. What is the ultimate benefit of using a RAM mixer? No critical analysis. None of the ethical issues are mentioned/discussed The bibliography is included beside the cited references. Relevant sources provided.		
Project Design (200 words) 205		
<i>Clear statement of which development methods are to be used and why they are appropriate.</i> <i>A clear statement of which tools are to be used and why they are appropriate.</i> <i>A clear description of how data collected will be analysed</i> Development methods/tools to be used and their relevance to this project are stated. The data evaluation approach is described	30	22

Resources / Planning (200 words) 50		
<i>List of any deliverables. Clear diagram showing both timing and resource use. Completed ethics form.</i> <i>Limited and relevant appendices</i> The deliverable outcome is specified in the introduction but should be repeated here as the summary of the work planned. The 200-word limit could be expanded and the outcomes discussed in more detail. Gantt chart is presented. The inclusion of key milestones would be useful. Completed Ethics Form is included	15	9
Document Presentation		
Correct spelling. Grammar and punctuation. The flow of narrative/fluency. Coherence. Word processed. Correct use of referencing with bibliography. Strict word limit for main text – 1000 words. Mostly correct spelling, grammar, and punctuation allow for fluent reading. Use Grammarly or Editor for improvement. The references and bibliography are properly presented in IEEE format	15	10

Word count close to the lower limit.		
A detailed table of content is provided to facilitate the navigation through the document		
TOTAL	100	64

PAGE 1

PAGE 2



Comment 1

on page 2 there is also Contents that should be included in the table

PAGE 3

PAGE 4



Comment 2

very good introduction statement. it clearly states the content of the rest of this document



Comment 3

bi- and tri-modal distribution should be shortly defined in footnote



Comment 4

what is the relevance of these to your project?

PAGE 5



Comment 5

what were the results of this research? how are they related to your proposal

Text Comment. all figures and tables must be mentioned in the text. sentences like 'as shown in Fig...' or 'as listed in Table...' are necessary when images or tables are included

PAGE 6



Comment 6

how your method can mitigate this risk?

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