

HAZID of Primer Sensitivity Testing
Procedure and an Understanding of
Small Arms Ammunition Primer Firing
Thresholds

Major Project Proposal

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HAZID of Primer Sensitivity Testing Procedure and an Understanding of Small Arms Ammunition Primer Firing Thresholds

1. Introduction

1.1 Research Purpose

The aim of this research project is to conduct a safety review of the hazards and risks involved in firing Small Arms Ammunition (SAA) primers and to develop a new firing procedure and test rig in order to conduct primer sensitivity testing. Furthermore, this testing will be used to understand primer sensitivity firing thresholds.

1.2 Objectives

- The hazards involved in the process will be collected and assessed using an appropriate safety tool (HAZID).
- Use of an appropriate Risk Assessment approach to mitigate the risks and produce a safe firing procedure with associated safety documentation.
- Develop a bespoke instrumentation rig.
- Conduct primer sensitivity testing using a large sample of primers.
- Evaluate the results of testing to better understand primer firing thresholds using statistical analysis.

1.3 Outcomes

In order for this project to be successful;

1. The safety review needs to capture all potential hazards/risks.
2. A safe firing procedure and test rig must be developed.
3. The test must generate sufficient data in order for the statistical analysis to be representative.

The outcome of this project will be the development of a primer firing test rig and a procedure to safely fire SAA primer caps. This rig and procedure will be more efficient than existing methods, meaning more data can be collected. The results will give a better understanding of the energy required to initiate a variety of small arms primers, which can support other project work related to ammunition and firearms.

2. Background Research

2.1 Primer Sensitivity Testing

In order for a primer to be accepted into service NATO's Standardisation Agreement for 9mm SAA determines that the primer sensitivity shall adhere to the following;

When tested by a procedure in the Manual of Proof and Inspection Procedures [1], using a ball of mass 55g (+/- 0.5g), *'all primers shall fire at a drop height of 305mm, and no primers shall fire at a height of 76mm'* [2].

In 2010, Lt Belcher [3] conducted a study at Cranfield University. The aim of the thesis was to investigate if the amount of percussion energy required to initiate a 9mm round altered with changes to velocity and mass. The results indicated that the required percussion energy does change with velocity and, in general, the required energy to ensure a round fires reduces as velocity increases.

A study [4] by J S Wilkerson investigated two different methods of measuring firing pin kinetic energy in order to establish the reliability of a firearm to fire primers. One method measured the force applied to the primer using a force transducer. The other method measured the depth of firing pin penetration, which was found to be a better approach.

In a similar study [5] Jorma Jussila looked at comparing the two different methods for measuring firing pin energy. In this study both methods gave reliable readings, and although most of the weapons tested provided sufficient energy to the primer for it to initiate, in a number of tests some weapons gave surprisingly low readings.

2.2 Review summary

The studies by Wilkerson [4] and Jussila [5] primarily looked at the energy delivered by a weapon firing pin, rather than primer initiation energy. This study recommended further research on weapon and ammunition primer compatibility, which requires a better understanding of primer firing thresholds.

Regarding primer firing thresholds very little research has been conducted. The Belcher [3] study looked at how changing the mass and velocity of the firing pin, but maintaining the same calculated kinetic energy, would affect the results. This study focused on how this relates to different firing mechanisms rather than the primer firing threshold ranges and therefore the data regarding this is limited.

This project proposes an improved instrument test rig, which is more user friendly and efficient, allowing for more data to be collected, in particular, at the firing thresholds in order to better analyse the probability of firings with different energy input.

This project proposes a different method of imparting energy from the firing pin into the primer, than that of the NATO Primer Sensitivity Drop test [1].

3. Project Design

3.1 Project Design Outline

This project will look at the requirements and safety factors to consider when planning and conducting the testing of SAA primer caps.

- Conduct HAZID and safety assessment. This is an effective method to identify the potential hazards of the proposed procedure.
- Risk Assessments/Method Statements/Firing Procedures will be produced to mitigate the risks to ALARP (as low as reasonably practicable).
- Design and manufacture of Instrumentation Test Rig.
- Pre-testing tasks – SAA de-bulleting and Test Rig calibration.
- Testing phase – The test rig will project a given mass through a barrel/tube. The velocity of this mass will be recorded. The mass will impact the primer and either cause it to initiate, or fail to do so. This will be repeated using different primer types and at different velocities.
- Results – The results will be statistically analysed to determine the probability of a primer firing for different values of kinetic energy.

3.2 Data collection

Observational Data - During the planning phase, information regarding the potential hazards will be recorded using an appropriate safety tool, such as HAZID.

During the testing phase, the velocity of the firing pin will be measured at the point of impact. This will be achieved by a series of light gates within the barrel that record when the pin flight passes.

The result of the impact, whether it initiates the primer or fails to do so, will also be recorded.

3.3 Risks & Limitations

3.3.1 Health & Safety

All personnel involved in the trial phase will be trained and competent in the handling of energetic materials [6].

Safety and Procedural Documentation will be written and authorised by Line Management and the Health & Safety team.

Primers that fail to function are treated as misfires and a suitable disposal method must be in place.

3.3.2 Financial

Project funds have been allocated for this research. The DSTL apprenticeship team also has additional funding that can be requested to ensure the research is completed [6].

Limitations – The research will have a maximum budget allowance that will influence the scale of the testing phase [6].

3.3.3 Technical

This research relies on key personnel, such as the lead researcher, remaining employed by DSTL [6].

The type and quantity of available SAA will be limited to current holdings within DSTL.

The design and manufacture of the instrumentation test rig relies on expertise within other teams in DSTL.

4. Resources and Planning

4.1 Resources Required

Manpower –

Lead Researcher, H&S, and Management approval required for planning phase

Up to 4 personnel (competent to handle energetics) required for pre-testing de-bulleting task and for the primer sensitivity testing phase.

Facilities –

Energetic Process Facility licensed to conduct ammunition de-bulleting

Suitable location to conduct primer sensitivity testing.

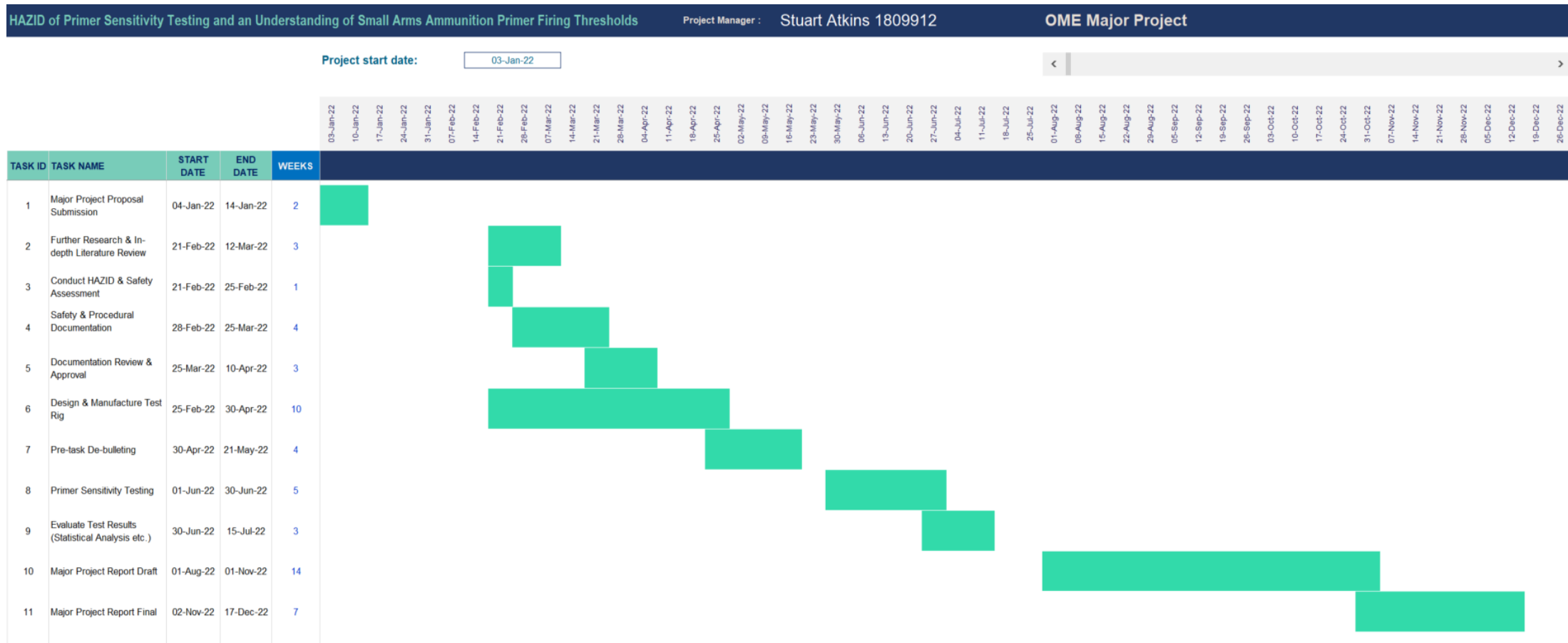
Energetics –

Up to 3000 rounds of 9mm SAA, with varying origins and manufacturers.

Instrumentation –

Test rig designed to use compressed gas to project a given mass towards a primer whilst also capturing its velocity.

4.2 Gantt Chart



5. Reference List

- [1] Primer Sensitivity Test Procedure Edition A Version 1. NATO Standard AEP-97 Multi-Calibre Manual Of Proof and Inspection (M-Cmopi) For NATO Small Arms Ammunition Vol 23. [Online]. Available - <https://diweb.hq.nato.int/naag/Public%20Release%20Documents/AEP-97%20MC-MOPI%20RD1.pdf> [Accessed: Jan 09, 2022].
- [2] Small Arms Ammunition (9mm Parabellum). NATO STANAG 4090 Edition 2. 15th April 1982. [Online]. Available - http://gigconceptsinc.com/files/STANAG4090-cartridge_9x19.pdf [Accessed: Jan 09, 2022].
- [3] Lt D Belcher, "9mm Primer Sensitivity" MSc Thesis, Cranfield Defence & Security, 2010
- [4] Wilkerson, J S. "Primer initiation". Final Report Abstract. United States: N. p., 1981. [Online]. Available - <https://www.osti.gov/biblio/6505129> [Accessed: Dec 10, 2022]
- [5] Jorma Jussila, "Validation of piezoelectric measurement system for weapon firing pin percussion energy" in Elsevier Journal Vol 43 Issue 3. April 2010. [Online]. Available - <https://reader.elsevier.com/reader/sd/pii/S0263224109002590?token=FOC8B0B0FAFE4C516D65B21ED00BE16231C0DA660902C2A995C02DA968E7A59DAD1D642EFED18E4C5969E060408EF991&originRegion=eu-west-1&originCreation=20220108202128> [Accessed: Dec 10, 2021].
- [6] S Atkins, "Effectiveness of Blast Mitigation in a Containment Vessel by using Hydraulic Energy Redirection". Research Proposal Module Submission, UWTSD. April 2021.
- [7] Free Gantt Chart Excel Templates. [Online] Available - <https://blog.coupler.io/gantt-chart-excel-template/> [Accessed: Jan 06, 2022]

6 Annex A – Ethics Form OME Students

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:	Stuart Atkins
2	Student Number:	1809912
3	Email address:	1809912@student.uwtsd.ac.uk
4	Programme of Study:	OME Level 6 Apprenticeship
5	Director of Studies/Supervisor:	Kapilan Radhakrishnan/Dave Holly

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	UWTSD Research Ethics & Integrity Code of Practice		☒
2	UWTSD Research Data Management Policy		☒
3	DSTL Code of Conduct		☒

SECTION C: Details of Research Activity

1	Indicative title:	HAZID of Primer Sensitivity Testing Procedure and an Understanding of Small Arms Ammunition Primer Firing Thresholds		
2	Proposed start date:	03/01/2022	Proposed end date:	31/12/2022
	Introduction to the Research (maximum 300 words in each section) Ensure that you write for a <u>Non-Specialist Audience</u> 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 Firing of Small Arms Ammunition (SAA) has been conducted extensively in the past and there are established safety procedures in place to ensure the safety of those firing the ammunition. The firing of primer percussion caps alone is uncommon and generally only occurs when ammunition is being tested before being accepted into service. An improved method of conducting Primer Sensitivity Testing is proposed to improve efficiency and provide a better understanding of primer firing thresholds.
4	Research Question Will an improved method of conducting Primer Sensitivity Testing provide a better understanding of primer firing thresholds?
5	Aims of Research Activity The aim of this research project is to conduct a safety review of the hazards and risks involved in firing primers, and to develop a new firing procedure and test rig, in order to conduct primer sensitivity testing. Furthermore, this testing will be used to understand primer sensitivity firing thresholds.
6	Objectives of Research Activity The hazards involved in the process will be collected and assessed using an appropriate safety tool (HAZID). Use of an appropriate Risk Assessment approach to mitigate the risks and produce a safe firing procedure with associated safety documentation. Develop a bespoke instrumentation rig. Conduct primer sensitivity testing using a large sample of primers. Evaluate the results of testing to understand primer firing thresholds using statistical analysis.
	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	Observational Data - During the planning phase, information regarding the potential hazards will be recorded using an appropriate safety tool, such as HAZID. During the testing phase, the velocity of the firing pin will be measured at the point of impact. This will be achieved by a series of light gates within the barrel that record when the pin flight passes by. The result of the impact, whether it initiates the primer or fails to do so, will also be recorded.

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?	☐	☒

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
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: N/A (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?	N/A
11	Who will the participants be?	N/A
12	How will you identify the participants?	N/A

	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			
	<i>(this box should expand as you type)</i>			

	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?	☐	☐	☒
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			
	<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: N/A	How you will mitigate the risk to participants:
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	
3	Risks to the investigator For example: personal health & safety, physical harm, emotional distress, risk of accusation of harm/impropriety, conflict of interest	
	Risk to the investigator: Safety risk in conducting energetic trials Work load stress	How you will mitigate the risk to the investigator: Competence and training. Conducting a Risk Assessment. Regular reviews and check-ins with line management and mentors. <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: Reputational damage	How you will mitigate the risk to the University: Research reviewed by technical experts within DSTL. Research conducted following the code of conduct expected by both DSTL and the University <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: Initiation of energetics produces waste gases	How you will mitigate the risk to environment: Air pollution of explosive products is accepted and unavoidable. DSTL has the authority to conduct explosive work.

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.

1	Feedback What de-briefing and feedback will be provided to participants, how will this be done and when?
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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.
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.

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, 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			
	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			

	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?	☐	☒

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:		
	All data will be kept on password protected Laptops. Any USB sticks used to store or transfer data will be password protected. Any data stored as manual files will be kept locked in a secure cabinet at my work premises that only myself and the security team have access to.		

	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):		
	All data will be encrypted and kept on password protected laptops. Any USB sticks used to store or transfer data will be password protected. All data transfers will be encrypted and password protected. Raw data from the testing will be shared with the customer funding the project. <i>(this box should expand as you type)</i>		
20	List all who will have access to the data generated by the research activity:		
	Principal researcher DSTL Mentor Course Supervisor Customer providing project funds <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:		
	Principal Researcher <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.		
	All data will be kept on password protected Laptops. Any USB sticks used to store or transfer data will be password protected. Any data stored as manual files will be kept locked in a secure cabinet at my work premises that only myself and the security team have access to. <i>(this box should expand as you type)</i>		
22	Confirm that you have read the UWTSD guidance on data management (see https://www.uwtss.ac.uk/library/research-data-management/)	☒	
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	☒	

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:	Stuart Atkins	Date: 09/01/2022
2	Director of Studies/Supervisor:		Date:
3	Signature:		

FOR INTERNAL USE ONLY:

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