JWS732, aerodynamics and propulsion laboratory users' notes

These notes are intended to be used as basic guidelines for operating procedures and processes for the JWS732, aerodynamics and propulsion laboratory on the main campus. They form a code of practice.

Contents

1 Introduction

This laboratory area is used for a variety of purposes for teaching and research work. Permanent fixtures include the flow visualisation wind tunnel, the turbojet test bed, and the German wind tunnel. Operation of the class 4 CW laser in the flow visualisation facility, the turbojet, and the propeller test rig and stroboscope for the German tunnel all involve understanding of the risks concerned.

2 Risk assessment

All project users should complete a risk assessment form for their activity. A guide to perceived risks is contained in these notes, see table 1. If you identify a risk that is not described, then make this clear in your risk assessment and inform the Aerospace Division Safety Officer of the perceived hazard.

3 Timetabled laboratories

Formally timetabled laboratories for undergraduate students are run in this facility. The laboratory demonstrator should advise students of the potential risks in the laboratory, and what steps should be taken to mitigate against them. Specifically:

1. Goggles should be worn if the flow visualisation laser (smoke tunnel) is running, and students should view the computer monitor in this case.

2. Ear defenders and ear plugs are available for when the turbojet is run. The stroboscope should not be run at less than 40Hz, and the safety guard should be placed in front of the wind tunnel working section when the propeller is run.

4 Out of hours policy

Out of hours working is permitted in the laboratory subject to the Aerospace Division being informed correctly.

5 Solo working policy

During normal working hours there is sufficient footfall in the level 7 area such that solo working in the lab area is possible. Otherwise the university lone working practice is explained at

http://www.gla.ac.uk/services/seps/a-z%20index/loneworking/

As a guideline:

1. Solo working on certain activities is absolutely forbidden.
2. The worker should be fully trained with the equipment, and the experiment must be mature.
3. Supervisors should periodically visit and observe people working alone;
4. Supervisors should maintain contact with lone workers using either a telephone or radio or possibly e-mail or SMS as available.
5. Contact arrangements should be documented as part of the risk assessment.
6. Use the signing in/out system.
7. Checks that a lone worker has returned to their base or home on completion of their tasks.

The guideline specifically mentions the supervisor, but this could be another competent person.

6 Model turbojet

A small model turbojet is used for undergraduate laboratories. It is safe if operated correctly. If you are assigned to a laboratory demonstration using the engine, you will be briefed on the starting procedure and the safety issues with the engine. The most likely failure mode for the engine is bearing failure. If this happens the engine will start to slow down even though the fuel flow rate is being maintained. If this happens set the engine control system to idle and then power it down. The laboratory system should not be tampered with, but perform the following checks:

1. Check for loose objects on the bench area in front of the turbojet. The engine has a foreign object damage screen, and ingestion velocities are low.
2. Check the exhaust tube is not blocked.
3. Check the assembly is bolted down firmly.

7 Flow visualisation wind tunnel

A small wind tunnel is located within another room in JWS732. The maximum wind speed is some 2m/s. The laboratory contains a smoke generator and a CW laser.

8 German wind tunnel

This small wind tunnel is in the general JWS732 laboratory. It has a maximum running speed of some 20m/s, and it is used mainly for 2nd and 3rd year propulsion experiments, and for 3rd year design project testing. A small propeller rig is run, and special safety precautions exist for it.

9 Laser and radiation safety

The flow visualisation wind tunnel has a CW laser as part of its instrumentation. New users should consult the guidelines explained by the university Radiation Protection Service, and complete their laser safety course. Details are on the website at
http://www,gla.ac.uk/services/radiationprotection
Other important notes are as follows:

1. Local laser safety guidelines are explained in table 1.
2. The laser has a designated key holder. The laser will not run without the key. To use the laser you will need to obtain the key off the key-holder, the key-holder will not provide access to the key without a completed risk assessment or if you have not had the appropriate guidance and training.
3. All laser users should be registered. E-mail Bill Ward at William.Ward@glasgow.ac.uk and explain what type of laser it is you are using, in which laboratory that laser is, and indicate your current level of experience.

10 Instructions for new users

Projects often take place within the laboratory area.

1. Complete a risk assessment form for your activity. See list of current perceived risks.
2. Gain familiarity with the environment. A more experienced person should give you a tour of the facility. Pay particular attention to your immediate working area, but you should take an interest in all areas also.
3. The university runs risk assessment and laser safety workshops. You should attend one.

11 Basic safety guidelines: what to do and what not to do

Accidents are usually the result of human error and may cause injury, damage to and destruction of equipment, or both. Below are some basic rules that you should follow:

1. Ensure that your experimental rig has been designed correctly, it should not fall apart during testing. There should be some evidence of an estimation of forces and a structural analysis.
2. Complete a risk assessment log.
3. Make sure you are fully prepared for your test.
4. First and foremost: you are in control of the working area where your experiment is being run. Do not attempt to do anything if you do not have the competence to do it or don't know your own equipment. Do not allow yourself to be distracted unnecessarily, and if there are others with you brief them on what will happen.
5. Before running the wind tunnel, ensure that there are no loose materials inside it, or anything attached that can be dislodged.
6. Ensure that you and any other personnel have laser goggles.
7. Never leave the wind tunnel running for no reason. If your test is finished, bring the flow to a halt.
8. Only run a laser when the beam is required.
9. Never distract someone who is conducting a test or is busy with equipment.
10. Never operate any equipment without someone knowing what you are doing and where you are.
11. Be especially careful if your rig has components that rotate at high speed. What would happen if a failure occurred? Steps must be taken to confine any failure.
12. Plan your work carefully.
13. Never work with laboratory equipment while tired.
14. Learn to know when to stop on a given working day. Anticipate how long the various tasks require, and plan ahead. Do not start something knowing that you do not have enough time to finish it.
15. Do not act impatiently with equipment. Take a step back if you begin to feel frustrated.
16. Keep access areas free from clutter.
17. Do not create tripping hazards.

12 Conduct in the laboratory

Your conduct affects the well-being of others who share the workspace. Treat their experiments with as much respect as your own, and never do anything that causes inconvenience to somebody else.

1. Never tamper with someone else's experiment.
2. Never 'borrow' a cable or an apparently minor item from someone else's set up.
3. Do not leave tools lying about.
4. Keep your laboratory environment tidy.
5. Report faults. Tag the equipment and tell your supervisor.

13 Risk guidelines

Table 1 shows a list of established risks, an explanation of precautions and user hints to help mitigate against them. Users should assess the risks against the needs of the test, and indicate whether the risk is present. This information can be used to help fill in a risk assessment form.

Table 1: Anatomy Building Wind Tunnel Risk Guide

#	Test/ facility	Risk	Precaution required	User hints	Risk present (yes/ no)
1	Flow visualisation	Class 4 CW laser, 532nm (in smoke tunnel): damage to eyes, skin, equipment.	Check if there are any reflections and block their transmission or their source. Cover windows with curtains. Build laser energy up carefully.	Use a flourescent card to detect reflections, or view general area with a camera.	
2	Flow visualisation	Oil spill: slippage	Identify where a spill might happen, usually at the seeder. Check other places where seeder routing pipes pass. Alert others and clean spill.	Use funnel to fill seeder. Do not overfill. Tighten reservoir covers.	
3	Flow visualisation	Use of oil seeder: tunnel floor can become slippy if oil used	Clean floors and place notice on wind tunnel door.	Don't allow an oil layer to accumulate.	
4	Flow visualisation	Cables: tripping hazard and risk of fouling equipment	Route cables carefully, fasten them down with tape, no loose trailing cables across access areas and in wind tunnels.		
5	Turbojet	Noise risk	Warn people that the jet will be run. Ensure that all personnel in the laboratory have ear defenders or ear plugs and that they are wearing them.		
6	Turbojet	Fire risk	Ensure fire blanket and fire extinguisher are available. Before jet is run advise of fire exit, and check that the door is not locked.	In event of fire, shut down system using the emergency stop and attempt to put out the fire using the blanket.	
7	Turbojet	Fumes	Open high and low level windows before the jet is run, and check that the exhaust tube is not obstructed.		
8	Turbojet	Fuel spillage	Mix and transfer fuel by the sink.	Make sure paper towels are available. Clean up small spills (a few drops) using paper towels. In the event of a large spill evacuate the room and contact the technicians	
9	Turbojet	Fuel storage	Use the jerry cans and the storage cupboard		

Table continued on next page...

#	**Test/ facility**	**Risk**	**Precaution required**	**User hints**	**Risk present (yes/ no)**
10	Turbojet	Engine failure	This could be mechanical, electrical or due to fuel starvation. Make sure fuel beaker is full before the test, and keep an eye on the fuel level as the experiment progresses. Mechanical or electrical failure will generally prevent the engine from starting, but the engine should be halted as quickly and as safely as possible if there is any unexplained loss or increase of engine speed without a change in throttle setting.		
11	German wind tunnel	Propeller	Ensure propeller is firmly attached to the motor spindle. Use the safety screen.		
12	German wind tunnel	Stroboscope	Do not operate below 40Hz. Ask personnel if they have problems with epilepsy or convulsions, and if so they should leave the room.		
13	German wind tunnel	Wind blast	Do not put hands into the flow. Make sure wind tunnel models are bolted down.		