AOE DEPARTMENT SAFETY REVIEW FORM FOR
EXPERIMENTAL RIGS

In the context of this form 'rig' refers to any potentially hazardous piece of equipment whose safe operation requires more detailed instructions and procedures than can be included in the Experimental Workspace Safety Review form for the area in which the rig is housed. Examples include a wind tunnel, laser system, high pressure tank, material testing machine, rotating system.

Before any such rig in the Department of Aerospace and Ocean Engineering is brought into operation, and **at least once per year** thereafter, a copy of this form must be completed, signed and submitted by the responsible faculty/staff member (usually the principal investigator). When an existing rig undergoes modifications which could affect its safety, a new copy of this form must have been submitted by the responsible faculty/staff member at that time, and before it is operated again.

Completed forms should be submitted to the AOE Assistant Department Head for Facilities (Michael Philen) and should also be made available to other faculty/staff with relevant expertise, or with direct involvement in the rig or space where it is housed. Any advice resulting from this interaction should be copied to the Assistant Department Head, as well as being transmitted back to the responsible faculty/staff member. Once the responsible faculty/staff member is satisfied that all safety concerns have been met the final version of the form should be signed and submitted and a copy displayed in a prominent position on or adjacent to the rig and on the department safety website. The responsible faculty/staff member may then authorize its operation. Under no circumstances may a rig be operated without a completed, current copy of this form prominently displayed.

Date of form .....Aug 15, 2024..... Form expires (no more than 1 year after form date): .....Aug 15, 2025.....

Name of Rig:..... **0.7m Subsonic Wind Tunnel**... .....

Workspace where rig is located..... 140 Goodwin Hall.....
Include room, building and name given to the space on the EHS training website.

Faculty/staff member responsible for the rig and its safety .....Aurelien Borgoltz.....

Office Address 660D McBryde Hall ..... Phone..... 231 1959..... Email .....aurelien@vt.edu.....

1. An evaluation of the above rig has been performed and the following safety risks have been identified (append details where necessary):

- **Risk of injury from obstruction of flow path. Air is driven through the wind tunnel using a fan located at its upstream end. Substantial obstruction of the flow path (such as standing in the test section) would expose an individual to unexpected aerodynamic loads or may dislodge hardware resulting in injury.**
- **Risk of physical injury from the external tunnel structure, attachments and probes. Parts of the facility, the models and instrumentation used with it have sharp projecting edges or points. Walking into or otherwise striking these (such as by tripping on cables) when in or around the tunnel has the potential to cause injury.**
- **Risk of fan failure. As with all systems employing axial fans there is a small risk of fan blade failure. Failure of fan blades could result in physical injury from flying debris.**

2. The following actions have been taken to minimize those risks (append details where necessary):
The risks described above have been minimized by developing and ensuring adherence to safe operating rules and procedures. These are described in attachment 1.

3. A safe operating procedure has been developed (attach the procedure to this form). This includes protective equipment to be worn, whether users may operate the rig alone and, if necessary, precautions to be taken by others working in the same laboratory. The procedure is in a form suitable for posting on the rig.
See attachment 1 and 2

4. Check one and include a list:

☑ *The rig may only be operated by the following individuals.*

☐ *The rig may only be operated under the supervision of the following individuals.*

This facility is used for required undergraduate courses as well as undergraduate and graduate research students. Undergraduate and graduate students receiving training as part of AOE 3054, 4105, 4106, -4205, 4206 and 4474are authorized operators during the laboratory hours of those courses. Other users must obtain the explicit approval of Dr. Aurelien Borgoltz (Lab supervisor and AOE3054 Course Organizer, aurelien@vt.edu, 231-1959) before using the facility.

5. The above individuals are all registered on the EHS training website at https://www.ehss.vt.edu/training/ and have taken all appropriate safety training courses. Their training is current and is recorded on the EHS website, under the above workspace name. The appropriate safety courses are (list here):

Electric Awareness
Portable Fire Extinguishers
Lockout-Tagout Awareness
HAZCOM RTK
Personal Protective Equipment (PPE) Awareness
Coronavirus Awareness

Signature of faculty/staff member responsible for the rig and its safety

.....  ..... Date..... Aug 15, 2024.....

ATTACHMENT 1
VIRGINIA TECH 0.7m SUBSONIC WIND TUNNEL OPERATING PROCEDURES.

This document describes procedures for users of the Virginia Tech 0.7m Open Jet Wind Tunnel. All authorized users must read this form before beginning work in the wind tunnel. Safety in the wind tunnel is taken very seriously. This document outlines some identified hazards and procedures that, when followed, my help to reduce risk of injury or damage. Ultimately, however, you the user bear the primary responsibility for your own safety and the safety of others around you.

CONTACT INFORMATION

Aurelien Borgoltz, aborgolt@vt.edu, 231 1959 (AOE3054 Course Organizer, Goodwin 140 lab manager)
Mike Philen, mphilen@vt.edu, 231 2548 (Assistant Department Head for Facilities)
John Burleson, jburles@vt.edu 231 4430 (Electrical Engineer and Lab Technician)

IDENTIFIED SAFETY RISKS

1. Risk of injury from obstruction of flow path. Air is driven through the wind tunnel using a fan located at its upstream end. Substantial obstruction of the flow path (such as standing in the test section) would expose an individual to unexpected aerodynamic loads or may dislodge hardware resulting in injury.
2. Risk of physical injury from the external tunnel structure, attachments and probes. Parts of the facility, the models and instrumentation used with it have sharp projecting edges or points. Walking into or otherwise striking these (such as by tripping on cables) when in or around the tunnel has the potential to cause injury.
3. Risk of fan failure. As with all systems employing axial fans there is a small risk of fan blade failure. Failure of fan blades could result in physical injury from flying debris.

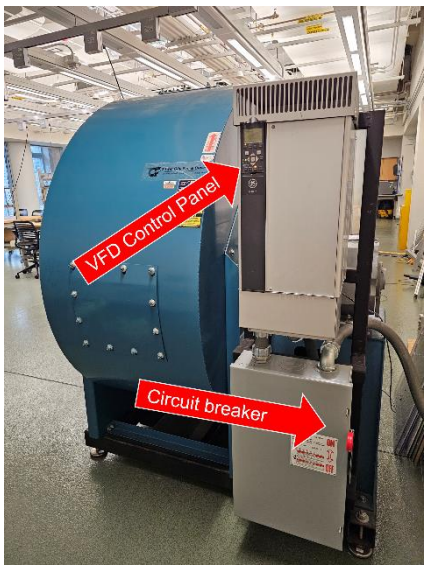
GENERAL SAFETY RULES FOR WORKING IN GOODWIN 140

1. All lab users must be part of the AOE 3054, 4105-6 or 4205-6 lab courses, or have the explicit approval of Aurelien Borgoltz before beginning work.
2. While working in the lab it is your responsibility to know
    a. the location of first aid and emergency equipment the locations of extinguishers and exits
    b. how to call the fire fighters, police or rescue squad (dial 911 from any campus or non-campus telephone).

   If you don't know, ASK before beginning work.
3. If in doubt about the safety of performing any test, of using any piece of instrumentation, or of undertaking any other operation in the lab, DO NOT proceed. No experimental result or setup is worth an injury.
4. Maintain and organized and clean work area. Access paths should be kept clear. Cables should not be draped across passages. Approved covers must be used for any cables on the floor.
5. Do not dispose of any chemical substance (down the sink, in the trash can or anywhere else). Disposal of such materials are to be handled by the department safety officer, Mr. James Lambert (jalamber@vt.edu, 231 6752).
6. It is your responsibility to immediately report to the lab director
    a. any injuries, accidents and "near-misses" that you are aware of
    b. any chemical spills, however small (e.g. mercury from a thermometer)
    c. any faulty equipment that poses a safety risk

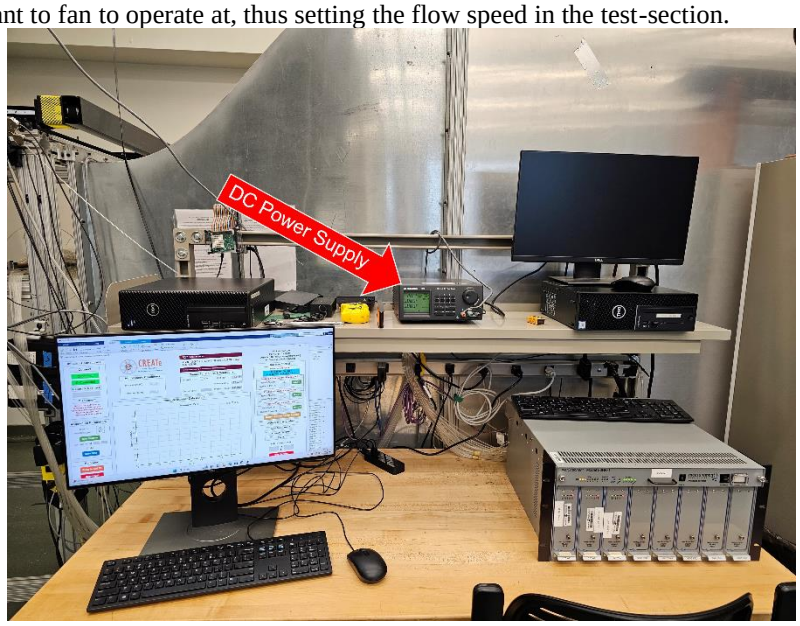
PROCEDURES FOR OPERATING AND WORKING WITH THE LOW-SPEED OPEN JET WIND TUNNEL

1. Use caution working in, on, or around the open jet wind tunnel.
2. Under no circumstances may the open jet tunnel be run without the jet catcher in place.
3. No item may be mounted in the flow path that would cause significant blockage (more than 25%) of the flow without prior approval from the lab director.
4. No user may be in, or may enter the flow path when the wind tunnel fan is on.
5. **Training is required before running the wind tunnel** and all users are required to be trained. If not officially provided by a lab TA or faculty member, training can be obtained from John Burleson 231-4430 jburles@vt.edu . The speed should be increased gradually at the start and during wind tunnel operations.
6. **Under no circumstances may the fan be running unless at least 2 approved users are present in the lab.**
7. While the fan is in operation listen for any rattling sounds that could indicate problems with its blades. Immediately shut down the system (follow the procedures below) and report the problem to the lab director if you feel there may be a problem.
8. The speed of the flow in the wind tunnel can be operated in 2 different ways:
   MANUAL OPERATION: The wind tunnel operates at a variable fan speed using the control panel located on the General Electric AF-600 FP variable frequency drive adjacent to the fan at the upstream end of the wind tunnel and shown on the right.



- **EMERGENCY SHUTDOWN FOR MANUAL OPERATION:** All tunnel users must be aware of the location of the circuit breaker (located behind the centrifugal fan, and shown on the photo on the right) before operating the facility. The circuit breaker is used to **energize the fan (pushing the lever up)** and can be used to **kill power to the fan (pull the lever down) to stop the wind tunnel** in case of emergency.

REMOTE OPERATION: In remote operation, the wind tunnel speed is controlled by a DC voltage signal provided by the grey DC power supply located on the bench next to the wind tunnel test-section (see photo on the below). A Matlab code on the computer located on the same bench will control the level of the DC voltage which in turns determines the fan RPM. Users can enter the RPM value they want to fan to operate at, thus setting the flow speed in the test-section.



- **EMERGENCY SHUTDOWN FOR REMOTE OPERATION:** In case of emergency, or if the Matlab control code does not respond, **the tunnel fan can be shut down by powering down the grey DC power supply (the power switch is located on the top left on the back of the power supply).** Reducing the supply voltage to 0 will bring the fan speed down to 0. If there is a need to de-energize the fan, users should proceed calmly to the back of the facility, near the centrifugal fan, and locate the circuit breaker. The circuit breaker is used to **energize the fan (pushing the lever up)** and can be used to **kill power to the fan (pull the lever down) to stop the wind tunnel** in case of emergency.
  - **Additionally, an emergency stop button is placed on the wall next to the centrifugal fan and can be used to kill power to the variable frequency drive at any time (see photo below)**

ATTACHMENT 2
MARINE PROPELLER AND DRONE PROPELLER RIGS
SAFE OPERATING PROCEDURES.

This document describes procedures for users of the two propeller rigs used for undergraduate laboratory courses (the marine propeller rig and the drone propeller rig). All authorized users must read this form before beginning work with the rig. Safety around this rig is taken very seriously. This document outlines some identified hazards and procedures that, when followed, my help to reduce risk of injury or damage. Ultimately, however, you the user bear the primary responsibility for your own safety and the safety of others around you.

CONTACT INFORMATION

Aurelien Borgoltz, aborgolt@vt.edu, 231 1959 (AOE3054 Course Organizer)
Mike Philen, mphilen@vt.edu, 231 2548 (Assistant Department Head for Facilities)
John Burleson, jburles@vt.edu 231 4430 (Electrical Engineer and Lab Technician)

IDENTIFIED SAFETY RISKS

1. Rotating machinery risks.
   a. Intentionally or unintentionally placing any body part in the rotor disk plane during high-speed rotation would result in severe injury.
   b. Any fixed article that is placed, or is dropped or propelled, into the rotor plane during operation would likely become a projectile launched across the lab or wind tunnel placing anyone in the vicinity at high risk of injury. It could also cause blades to become detached and also be launched as projectiles.
   c. Any loose clothing placed near the rotating parts of the system could become entangled, drawing the wearer into the rotating blade system and resulting in injury.
   d. Modifying the moving parts of the rotor system in any way, such as attaching items to the blades or within the hub, without appropriate balancing will cause the rotor system to become unstable at speed. The resulting vibration and mechanical stress could cause the rotor system to move from its mount, to fail, or to propel any loose item or debris across the lab or wind tunnel. This would expose personnel nearby to significant risk of severe injury.

PROCEDURES FOR OPERATING AND WORKING WITH THE MARINE PROPELLER AND DRONE PROPELLER RIGS

The procedures below are in addition to those required for working in Goodwin 140. Only the trained personnel explicitly named on the safety form, and approved by Aurelien Borgoltz, are authorized to operate the rotor rigs. In the following procedures "operation of the rotor rigs" refers to any situation in which a rotating component or components are to be spun using the drive motor, regardless of whether those components comprise the complete rotor system.

1. All laboratory or wind tunnel setups in which the rigs are to be operated under power must be explicitly approved in advance by Aurelien Borgoltz. Any changes to the configuration, including but not limited to any changes in the rotating part of the system, changes to the system power, changes to the placement of the system or of any protective or other hardware placed around it must be explicitly be approved in advance by Aurelien Borgoltz and John Burleson.
2. Propeller rigs may not be set up in the open jet wind tunnel without the presence of John Burleson.
3. Undergraduate students are not permitted to operate the propeller rigs without supervision of a graduate teaching assistant that has been properly trained.
4. A minimum of two people must be present in the room when the rig is under power. All people present must have read this form.
5. It is the responsibility of all people present in the room to know the emergency shutdown procedure (below), and to ensure clear paths to the critical items needed for shut down *before* the rig is placed under power.
6. When personnel are operating one of the rigs in the open-jet wind tunnel a Lexan shield must be used to create a barrier between the rotor and operators. The shield must remain in position at all times when the rig is powered.
7. Users may not operate or assist with the rigs when wearing loose clothing or clothing (such as a tie) that could become entangled.
8. Nothing may be attached to the rotating components of the system without the prior explicit approval of Aurelien Borgoltz.
9. Special precautions for operation of the rigs in the Stability Tunnel
   a. Before operating the rotor system, The Lexan shield must be properly placed on the side of the test-section, parallel to and out of the flow. Lexan shield *must* be free to swing to maximize its effectiveness.
   b. All personnel in the room must be notified before the rig starts rotating.

EMERGENCY SHUTDOWN PROCEDURE.

In the event of an emergency, the marine propeller rig rotor can be shutdown one of 2 ways:

a. Kill power
b. Shutdown

In the event of an emergency, the drone propeller rig rotor can be shutdown one of 2 ways:

a. Kill power
b. Shutdown command

These methods should not be used for normal operation. Emergency shutdown could cause rapid deceleration of the rotor rig and may result in damage to the experimental apparatus.