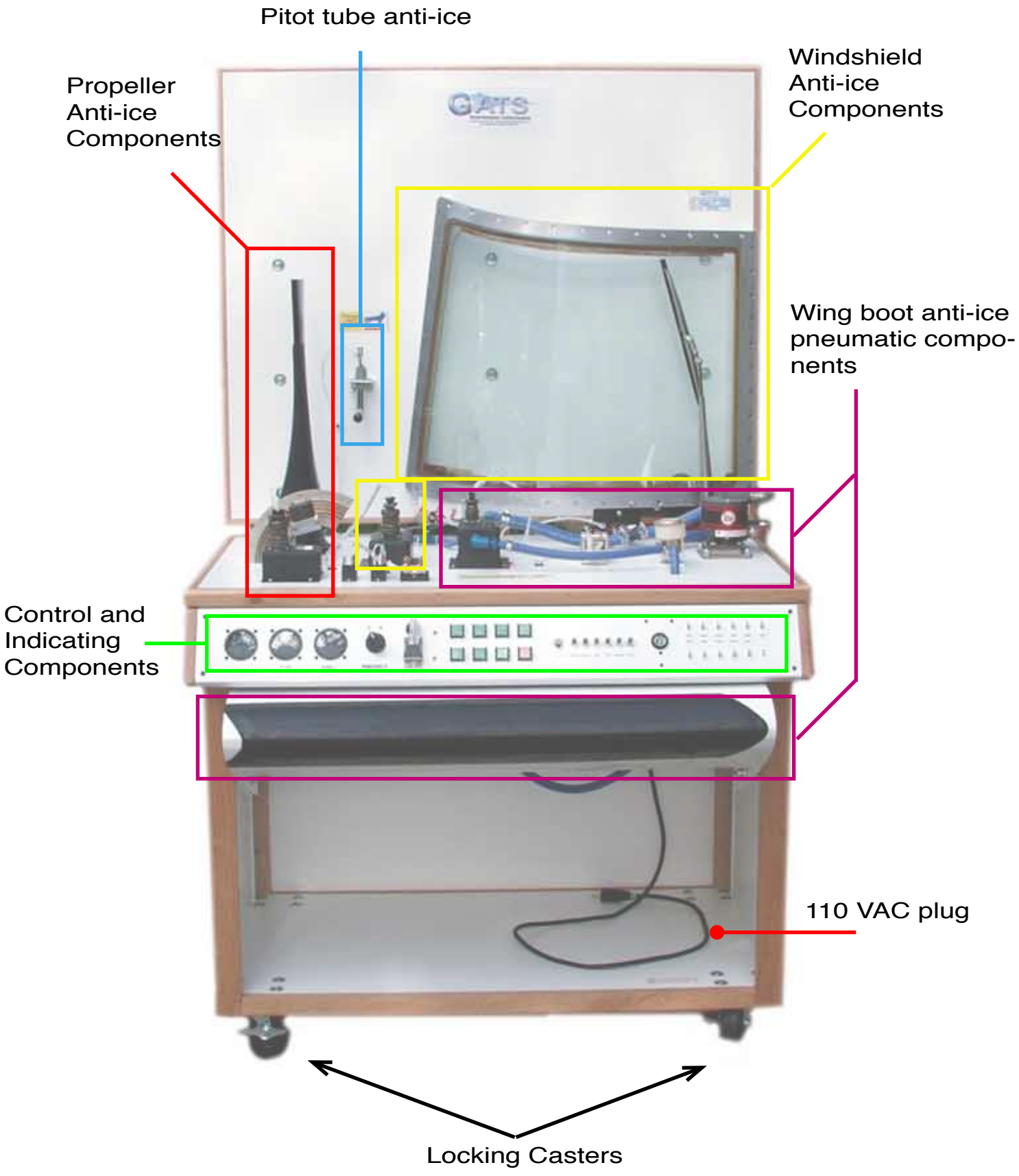
Ice & Rain Trainer

Component Location



Description and operation

Ice & Rain Trainer Description

The IRT-R5 is a fully functional Ice and Rain Protection system. It incorporates an anti-ice thermal blanket on the propeller, heated Pitot tube, anti-ice windshield, pneumatic wing de-ice boot system, electric windshield wiper, and all necessary components and control devices providing an excellent trainer representative of a typical aircraft ice and rain system. Extreme caution should be observed at all times when activating this trainer. Students should not operate this system without instruction and supervision.

A 24 volt DC power supply activates the various components of the Ice & Rain trainer to allow operation as well as troubleshooting. Faults that have been integrated into the trainer to allow the instructor to challenge the student.

In addition certain safety features have been incorporated to allow operation of these systems during ground operation. Please note that operating the various systems during ground operation of the aircraft would not be allowed. The anti ice windshield would never be cycled on during ground operations as the temperature of the windshield could cause distortion in the field of vision for the pilot. The pitot heat is typically selected on just prior to takeoff as the heat generated is considerable. The students need to understand the operation of these units without cooling air provided by flight would require caution on operational aircraft.

The vacuum system in a typical aircraft is always suppling either vacuum or pressure to various instruments and aircraft systems. The pressure side of the vacuum pump on the IRT-R5 when the de-ice boots are cycled is closed and therefore loads the pump, the RPM of the pump will change significantly when the boot is inflated, this is considered normal.

Description and operation

Propeller thermal blanket

The propeller is guarded from ice accumulation before entering icing conditions by selecting the propeller de-ice system on. In addition the propeller thermal blanket can shed ice if the ice build up begins before the propeller de-ice is selected on.

When the propeller de-ice is selected on the circuit breaker provides power to the on off switch which routes power to the propeller de-ice control module. The control module will cycle current to the electrically heated thermal blanket that is glued to the propeller blade. The thermal blanket has two elements embedded into the rubber plys that warm due to electrical resistance. There is an "inner" and "outer" heating element. The control box will start the primary heating cycle by heating the outboard element first. This allows the centrifugal forces acting on the propeller blade to sling the ice that is located closest to the tip to depart the propeller blade first. The controller will after a pre determined time discontinue heating the outboard section and heat the inboard section of the propeller thermal blanket. As the Ice melts the centrifugal forces will sling the ice located on the inboard section of the boot. When this second cycle completes the propeller should be clear of ice. When the propeller completes its heating cycle on the initial engine on a multi engine aircraft the prop control will then cycle the second engine in the manner. The IRT has a twin engine controller, this provides a cooling cycle for the propeller boot. The propeller de-ice controller will repeat the cycle continuously until it is selected off by the pilot. Current is provided to the thermal blanket by a slip ring and brush block assembly. The slip ring rotates with the propeller and the brush block remains stationary. The brush blocks are in three separate modules so they can be removed or replaced independent of each other.

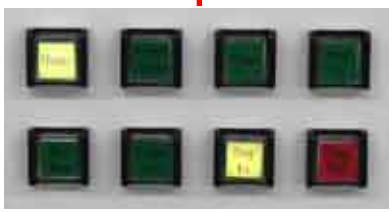
Description and operation

Propeller
Thermal
Blanket

Prop
De-ice
Brush
Block

Prop
De-ice
Controller

Prop
De-ice
Gauge



Prop De-ice
switch

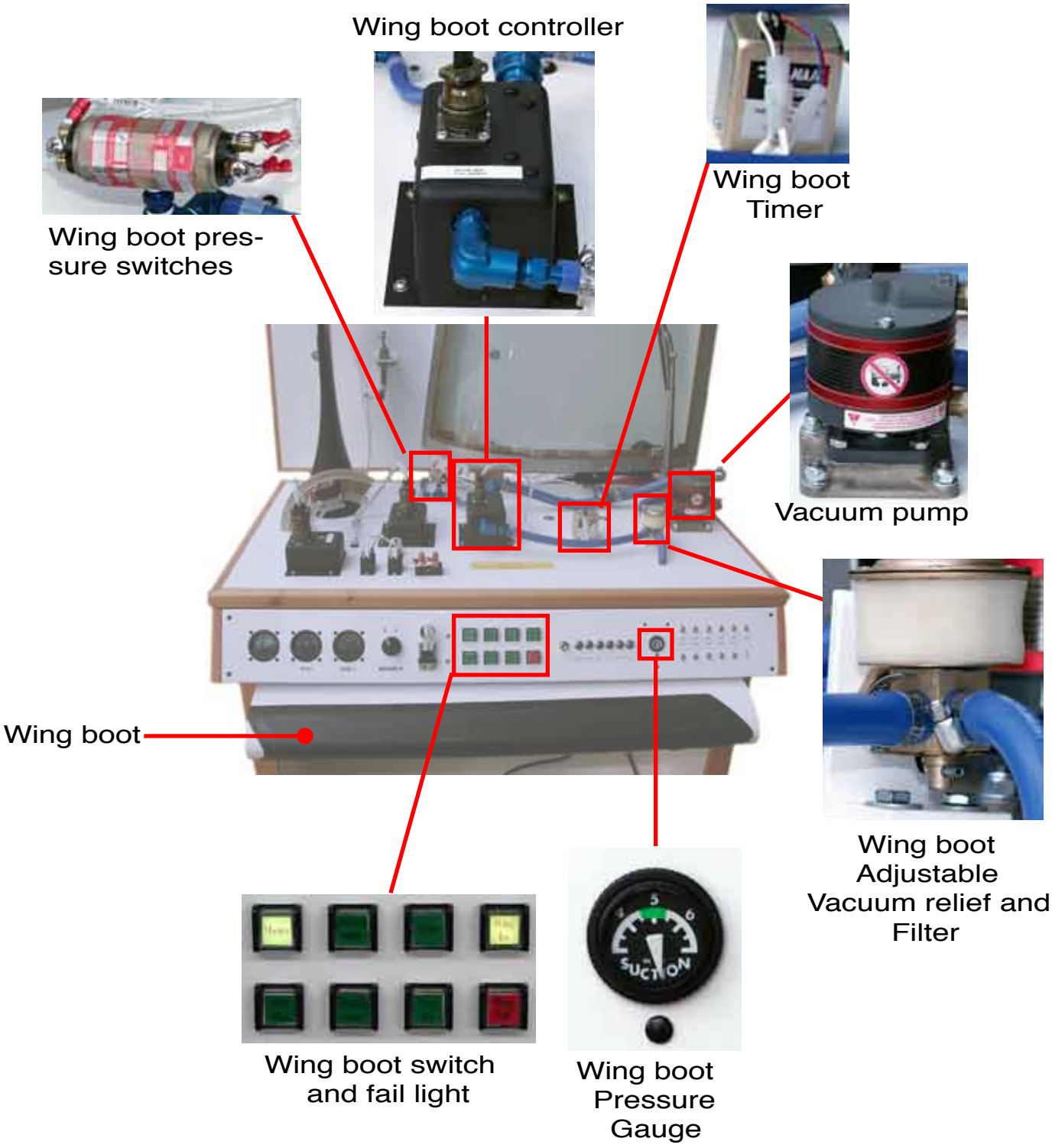
Description and operation

Pneumatic Wing Boot Description

The pneumatically operated wing boot system is controlled by the pilot when ice forms on the leading edges. Ice accumulation is required before the boots are selected on. The ice must be of a minimum thickness so when the boots expand the ice will break. If the ice is to thin when the boots are cycled it may not break and this could lead to more ice accumulation causing the ice to be harder to shed from the airfoil. Once the pilot depresses the momentary "wing ice" switch the boots will cycle through the inflation, deflation, vacuum process automatically. The boots do not cycle again until the pilot determines another cycle is required.

With activation of the wing de-ice switch, the deflate valve closes and vacuum is removed from the boot. Power is supplied to the boot control valve allowing pump pressure to flow to the boot. The inflating of the boot breaks the ice from the leading edge of the wing. The wing de-ice light will illuminate during the inflation cycle. Once the boot timer has reached the seven second duration the timer removes current to the de-ice control valve allowing the trapped air in the boot to exhaust to the atmosphere through the deflate valve. When 2 PSI is reached in the boot the deflate valve will energize the vacuum valve, close the exhaust valve apply vacuum to the boot holding the boot tight to the wing. If the boot is not held tight against the wing the aerodynamic forces acting on it will pull the boot away as if it were partially inflated.

Description and operation



Description and operation

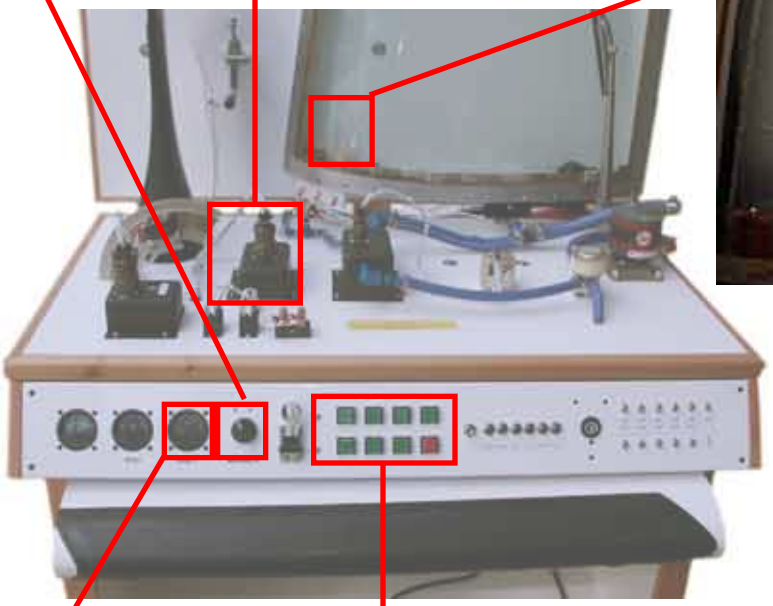
Heated windshield description

The heated windshield has a high and low position and is designed to heat the windshield so ice cannot form on the windshield and obstruct the pilots vision. The windshield contains two separate heating elements and one resistance sensor. When power is applied to the windshield the windshield will begin to heat. As the windshield heats, the embedded sensor wire located in the lower corner of the windshield will change resistance. The windshield controller looks at the resistance of the windshield and determines the duration of the on or powered cycle by that resistance. When the windshield resistance reaches the predetermined point the controller cycles the windshield off. The high windshield cycle operates and is controlled in the same manner.
When the windshield is selected to high it does not get hotter but has more current to stay at temperature. The out side atmosphere will dictate the windshield settings the pilot will select.

Description and operation

Windshield Temperature Selector

Windshield Temperature Controller



Windshield Temperature Sensor

Windshield Amperes Gauge

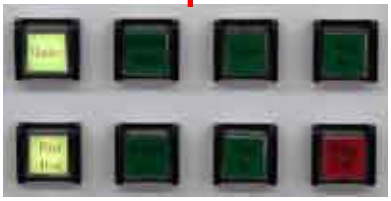
Windshield high and Low switch

Description and operation

Pitot tube description

The pitot tube is an electrically heated tube that prevents the formulation of ice ensuring the proper air data is supplied to the various instruments. To prevent ice from accumulating on the tube a resistance coil is built into the tube. By switching on the pitot tube, current is provided to the element causing it to generate heat. The pitot tube should never be turned on and left on during ground operation on operational aircraft. The GATS systems trainer is specially design so this is possible on a controlled basis.

Pitot tube

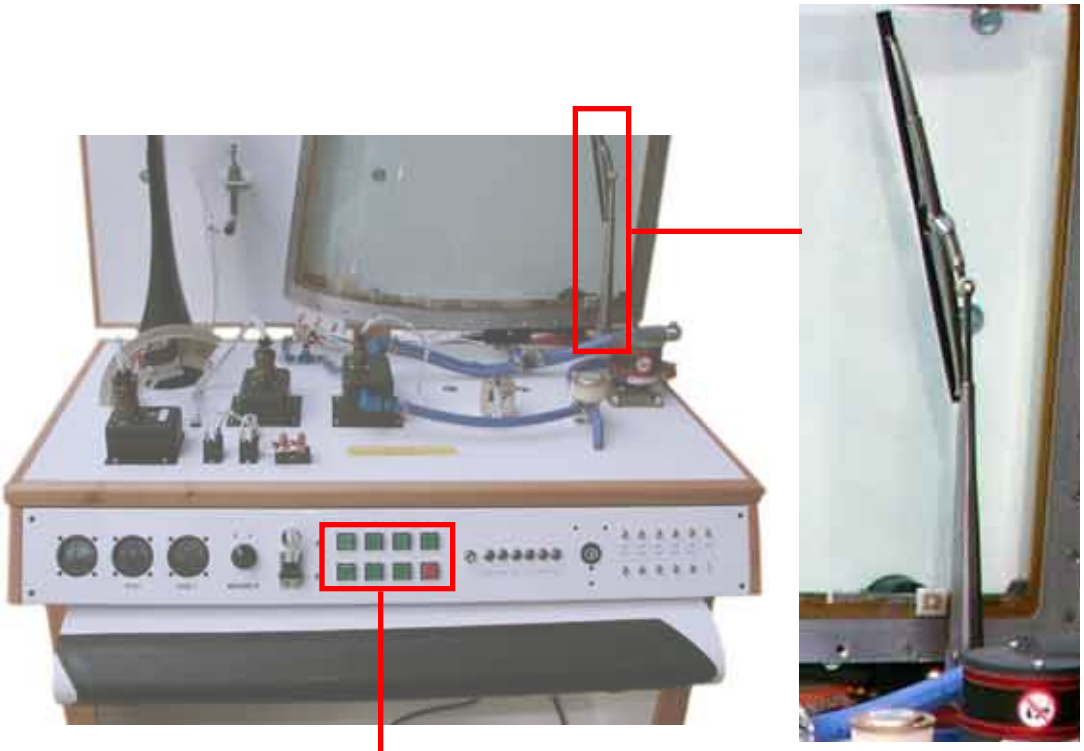


Pitot tube switch

Description and operation

Windshield wiper description

The windshield wiper is designed to improve the pilots visibility during ground operation, take off, and landing phases of flight. The wiper is controlled by a switch installed on the panel. In addition the wiper has a self parking feature that will return the wiper to specific location when the switch is selected off.



Wiper assembly

Wiper switch

System Set Up POWER OFF

TRAINER SET - UP

Position the trainer in a stable location and provide room for student access around the unit. Lock the brakes on the casters .

CAUTION; When moving the trainer have no less then 3 people. The unit is top heavy and will want to fall to the rear. You must support the unit and not allow the unit to tip. Never push the unit with the back board facing in the direction of travel. ALWAYS push the unit from its side and traveling to its side.

POWER ON

SYSTEM DEMONSTRATION

After completion of the setup procedures the trainer functions as follows:

Power-Up the IRT-R5 by selecting the master switch to the “On” position. This provides the necessary 24 volts DC required for operation of the aircraft systems.

Pneumatic boot operation, set the fault switch position as follows
FS1 Down FS11 Down

Select the pump switch on, the vacuum pump will start rotating and both pump pressure and vacuum will be supplied the boot system. Excess vacuum pump pressure is routed to an exhaust hose pointed directly at the vacuum pump. This cooling air will help cool the pump. Vacuum pumps are designed to be cooled in flight by the cooling air rushing throughout the engine cowling. The operation of the vacuum pump shall be held to a maximum of 5 minutes. Allow the pump to cool before starting another pump on cycle.

Set the vacuum pump as follows;
Select the vacuum switch on (up). Check the vacuum gauge, the needle should be in the green arc. If adjustment is necessary bend the lock tabs so the roll pin on the bottom can be rotated. In to increases and out decreases. Once the pressure is set bend the lock tabs back into position.

Vacuum Switch

Vacuum Gauge

Adjustment

CAUTION; The vacuum pump gets very hot while in operation and will be after operation, DO NOT TOUCH the pump during these times.

POWER ON

Hot windshield operation, set the fault switch position as follows

FS2 Up FS3 Up FS4 Up FS7 Up
FS8 Up FS9 Up

Due to the very high amperage requirements of a heated windshield a potentiometer has been installed to replicate the increased resistance in the heat sensor normally generated by the heating elements embedded in the windshield. Additionally the windshield can be operated by carefully heating the sensor elements embedded in the windshield with a heat gun. The IRT-R5 connections from the controller to the windshield are insulated to prevent a complete electrical path to the heating elements. Voltage checks can still be taken at the insulated windshield LP terminal locations.

Windshield low operation;

With the master switch on select the windshield temperature simulator knob all the way to the counterclockwise position. Press the windshield low switch to turn on the windshield. Check the windshield amps, they should be approximately 26 amps. Slowly rotate the windshield temperature selector towards the "H" position clockwise and the windshield will cycle off. You have increased the resistance sensed by the windshield controller with the potentiometer simulating the windshield as it heats.

Windshield Temperature Control

The windshield controller senses the changes in resistance induced by the windshield temperature control. Rotate the windshield temperature control towards the cold or "C" position and cycle the windshield off. Rotating the temperature control counter clockwise will signal a lowering of the resistance of the windshield sensor element as if it was cooling and again the windshield

POWER ON

Hot windshield operation in high requires the windshield to already be operating in the low position. There are two different heating elements embedded in the windshield so for the windshield to operated in the high position they must both be heated. Rotate the windshield temperature simulation control counterclockwise until the amperage gauge reads amperage again and then select high by depressing the windshield high push button switch in. The amperage gauge will read approximately 50 amps.

You may also cycle the windshield by heating the embedded sensor in the windshield. First set the windshield temperature knob so that the windshield amperage gauge initially shows indication, this may require rotating the knob back an forth several times. This will reduce the heating of the windshield. Glass is a poor conductor so it will take some time for the windshield to warm enough for the embedded elements to change resistance and shut the windshield off. In addition the windshield heating elements generate heat from inside the windshield instead of heating from the outside. Carefully wave the heating gun back and forth continually and remove the heat gun from time to time to allow the heat to saturate the glass then return the heat gun and continue this sequence until the amperage gauge indicates zero. This indicates the windshield controller has sensed a change in the sensor resistance and cycled the windshield off. This may take up to 5 minutes to heat saturate the glass from the outside with the heat gun. The windshield will cycle back on when the glass becomes cool enough but this will take some time at room temperature. To return the windshield to operation rotate the temperature knob.

The student can connect an Ohm meter to the window sensor test points located on the outer windshield frame. Take ohm meter readings with the windshield cold. With the heat gun, apply heat to the sensor area on lower right corner of windshield. With an ohm meter, still connected to the meter points, students should see an increase in the resistant reading on meter.

Windshield terminals

CAUTION; Localized heating of the windshield may break the glass. DO NOT keep the heat gun on the glass consistently. Wave the heat gun back and forth never stopping at any time. Remove the heat gun and allow the heat to saturate the glass.

POWER ON

To operate the propeller de-ice select the Prop Ice push button switch to on. The timer alternates between the inboard and outboard resistive wires imbedded in the thermal blanket. The amperage draw is indicated on the instrument panel “Prop Amp Gauge.” Normal operation would reflect the prop amp gauge in the “Green” arc. Note the gauge reads approximately half way to the green arc, this is due to the fact that there is only one boot install in the system. All aircraft installed systems would always include two or more thermal blankets. The pointer will momentarily deflect when the timer switches outboard to inboard, etc. Using your hand you can feel the temperature rise on the thermal blanket.

Prop De-ice Switch

Thermal Blanket

POWER ON

The windshield wiper is operated as follows, to reduce scratching of the windshield it is recommended that the windshield be cleaned prior to use of the wiper. Depress the windshield wiper switch to activate wiper in “slow” mode. The high speed setting has been disabled to prevent a possible hazard associated with wiper moving at high setting and student contact. When wipers are turned off they will move into the “parked” position.

CAUTION; The windshield motor is powerful ensure all personnel are clear of the windshield area before initiating the wiper system to on.

Wiper Switch

Wiper assembly shown in the parked Position

POWER ON

The pitot heat is activated by depressing the “Pitot” switch. This will provide a complete path to the embedded resistant wires located in the Pitot tube. A “Time Delay” relay is incorporated in the circuit to remove power from the Pitot heat element after approximately 1.75 minutes. Remove the pitot tube protective cover before heating the tube. For safe operation of the Pitot tube an in line (series) heat dissipating resistor has been installed in the simulator base unit. The resistor provides some personnel and unit protection from the heat generated in the tube.

CAUTION; DO NOT OPERATE PITOT TUBE THOROUGH NUMEROUS CYCLES. HEAT GENERATED WILL DESTROY UNIT.

Pitot heat switch

Protective cover

Curriculum

Drawing #30-10-01-1

Pneumatic Boot
Master on - System off

30-10-01-1 -- Shows the Pneumatic system with Master “On” and power provided to the buss. The wing ice switch is selected off, the 2 PSI switch is closed providing power to the de-ice flow control valve on pin "C". The flow control valve has a vacuum valve (internally) that is open providing vacuum to the boot. See FCV-1 for the flow control valve operation.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

Curriculum

Drawing #30-10-01-2

Pneumatic Boot
Master on - Wing de-ice switch ON - System Normal
Reference power wires are orange

30-10-01-2 -- Shows the Pneumatic system with the master “On” and power provided to the buss from the 24 volt power supply through a circuit breaker. With activation of the wing de-ice switch (momentary), the deflate valve opens and vacuum is removed from the boot. Power is supplied to the 10 psi switch. (normally closed), then powering the De-ice flow control valve. In addition the Pump cooling valve is de-energize to make all available pump air for the boot. See FCV-2 for the flow valve configuration.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

Curriculum

Drawing #30-10-01-3

Pneumatic Boot
Master on - Wing de-ice switch ON
System failed - overpressure.
Reference power wires are orange

30-10-01-3 -- Shows the Pneumatic system with the master “On” and power provided to the buss, from the 24 volt power supply through a circuit breaker. With activation of the wing de-ice switch (momentary), the deflate valve opens and vacuum is removed from the boot. Power is supplied to the 10 psi switch. The normally closed 10 PSI switch is closed due to an overpressure on the boot system and has tripped the boot fail light relay. The De-ice system is designed that in the case of a boot overpressure condition the warning lamp will have to be extinquished by the pilot by pressing the fail indicator, disconnecting the ground from the relay. The flow control valve has returned to is normal vacuum applied position.

See FCV-3 for the flow valve configuration.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

Curriculum

Drawing #30-40-10-1

Windshield de-ice
Master on - Windshield de-ice switch low ON

The master switch on with the windshield low switch on and the windshield not yet up to temperature to cycle.

30-40-01-1 -- Shows power supplied from the buss to the windshield controller and windshield low relay. The windshield low switch is pushed in and powers the windshield controller. The indicator lamp is illuminated and the controller is energizing the low relay which connects the buss supplying power to the low terminal on the windshield.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

Curriculum

Drawing #30-40-10-2

Windshield de-ice

Master on - Windshield de-ice switch on high

The master switch on with the windshield low and high switch on and the windshield not yet up to temperature to cycle.

30-40-01-2 -- Shows power supplied from the buss to the windshield controller and windshield low relay. The windshield low switch is pushed in and powers the windshield controller. The indicator lamp is illuminated and the controller is energizing the low relay which connects the buss supplying power to the low terminal on the windshield.

When the high switch is closed power is supplied all the time to the coil on the windshield high relay. Current is supplied to the windshield high relay contacts from the output contacts on the low current relay. Current passes through the contacts on the relay to the high terminal on the windshield. The windshield is on high hot.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

Curriculum

Drawing #30-40-10-3

Windshield de-ice

Master on - Windshield de-ice switch high

Windshield cycling

The master switch on with the windshield low switch on, the windshield high switch on and the windshield at temperature to cycle.

30-40-01-3 -- The controller has sensed a change in the resistance of the embedded sensor. The resistance is of sufficient value to trip the windshield controller to off. The controller cuts power to the low relay witch opens the contacts. The opening of the contacts on the low relay removes power from the windshield high relay dropping power from both the low and high terminals of the windshield.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

Curriculum

Drawing #30-30-01-1

Heated pitot tube

Master on - Pitot tube switch on

The master switch is on and the pitot switch on.

30-30-01-1 -- The pilot has been advised that he is flying into known icing conditions and has selected the pitot tube on. The single shot relay is allowing the heated pitot tube to operate for the ground allotted time.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

NOTE;

The IRT-R5 has a single shot timed relay that would not be found on aircraft. Additionally the IRT-R5 has an in series resistor to limit the heat generated by the pitot tube, on any operational aircraft the pitot tube would heat MUCH FASTER!

Curriculum

Drawing #30-60-01-1

Propeller heat

Master on - Propeller heat switch selected on

The master switch is on and the propeller switch is on.

30-60-01-1 -- The pilot has been advised that he is flying into known icing conditions and has selected the propeller heat on. The outboard section of the de-ice boot is heating.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

NOTE;

Curriculum

Drawing #30-60-01-2

Propeller heat

Master on - Propeller heat switch selected on

The master switch is on and the propeller switch is on.

30-60-01- -- The pilot has been advised that he is flying into known icing conditions and has selected the propeller heat on. The outboard section of the de-ice boot has finished its heating cycle and the inboard boot is now heating.

Cautions:

Student must exercise caution when doing voltage checks, turn power off for any continuity checks.

NOTE;

Curriculum

Instructor Introduced Faults

The instructor may introduce various faults in the system and it will be the responsibility of the student to determine the malfunction and corrective action.

FS (fault switch) 1 Pilot Report;

When I select the boot de-ice switch to the on position the wing boot pulsates and the wing ice light flickers at about the same frequency. The wing fail light is also on. The boot seems to pop the ice of but not like it should.

Repair; Drawing # 30-10-01-FS1

The 10 PSI switch has failed and is opening at to low of a pressure causing the system to oscillate. Power to the cannon plug B pin is re-ceiving momentary power.

FS 2 Pilot Report;

When I select the windshield to low or high the lights come on but no amperage is shown on the gauge and it will not de-ice or even defog the windshield.

Repair; Drawing # 30-40-10-FS2

The wire H40A18 carrying current from the windshield shunt to the wind-shield low relay is broken and will need replacement.

FS 3 Pilot Report;

When I select the windshield to high it seams to be operating and the amperage gauge is reading 50 amps but the windshield high lamp is not illuminated.

Curriculum

Repair; Drawing # 30-40-10-FS3

The wire H41C18 carrying current from the windshield high relay to the indicator lamp is broken and will need replacement.

FS 4 Pilot Report;

When I select the windshield heat to either high or low the indicator lights come on but there is no amperage indication in either high or low and I hear a clicking sound.

Repair; Drawing # 30-40-10-FS4

The wire H41D18 carrying current from the windshield controller to the windshield low relay is bad. Replace the wire or terminal.

The clicking heard is the high relay still working but power is provided to the high relay contacts from the low relay so no power is passing through the relay contacts, indicator lamps are .

FS 5 Pilot Report;

When I select the wiper on it works fine. When I select the wiper off it just stops wherever it is located.

Repair; Drawing # 30-40-01-FS5

The wire H50B18 connecting the wiper switch to the park wire is disconnected. This disables the park feature on the wiper and it will stop where ever the wiper is located in its arc.

FS 6 Pilot Report;

When I select the pitot heat on I get no amperage indication but all the instruments that reference the pitot air keep working so I think it is still working but I'm not sure.

Curriculum

Repair; Drawing # 30-30-01-FS6

The wire H60D18 connecting the amperage gauge to the shunt is bad and needs repair. The gauge is not connected to the system but the pitot tube is operating.

FS 7 Pilot Report;

When I select the windshield heat to either high or low the indicator lights come on and there is amperage indication in either high or low but the windshield will not cycle off I have to shut the windshield down manually.

Repair;Drawing # 30-40-10-FS7

The wire H41M18 connecting the sensor to the controller is bad and needs repair. The controller can not sense the temperature of the windshield so it will not cycle.

FS 8 Pilot Report;

When I select the windshield heat to either high or low the indicator lights come on but the windshield does not indicate an amperage draw on the gauge and it is not getting hot

Repair; Drawing # 30-40-10-FS8

The wire H41Q18 connecting the controller to ground is bad and needs repair. The controller can not operate without a ground.

FS 9 Pilot Report;

When I select the windshield heat to either high or low the indicator lights come but there is amperage indication only on high. When the windshield is on low there is no amperage draw.

Curriculum

Repair; Drawing # 30-40-10-FS9

The wire H40B18 connecting the controller to the low terminal on the windshield is bad and needs repair. The relay is not connected to the windshield.

FS 10 Pilot Report;

When I select the Prop de-ice on, the system seems to work part of the time. The indicator light comes on and the amperage gauge indicates a draw and then goes to zero. Is this normal? Is the timer pausing between cycles.

Repair; Drawing # 30-60-01-FS10

The wire H30H18 connecting the prop de-ice brush block to the prop boot is bad. Possibly the wire connection on the brush block assembly is bad, the brushes are dirty or worn out, or the brushed are misaligned.

FS 11 Pilot Report;

When I select the boots to the on position they do not inflate. The wing ice light is on but the boots will not inflate. The fail lamp is not illuminated.

Repair; Drawing # 30-10-01-FS11

The wing boot flow control valve is defective and not suppling air pressure to the boot. Reference purple wire on drawing 30-10-01-FS1 has no power. The boot fail lamp will not illuminate, it is an overpressure indicator.