COLD WEATHER PROTECTION - GENERAL

1. General

This section contains the maintenance procedures for the removal of ice, snow, and frost from the aircraft, and the data for the protection of the aircraft against cold weather.

De-icing is an application of heated water, or an application of a heated mixture of de-icing fluid and water to remove ice, snow or frost from aircraft surfaces.

You can use infrared energy as an alternative procedure to remove frozen precipitation (de-icing).

Anti-icing is a treatment with an overspray mixture of anti-icing fluid and water, or a concentration of anti-icing fluid applied to the aircraft. This procedure is done to prevent ice, snow, or frost on the protected surfaces.

There are two types of procedures to do de-icing/anti-icing on an aircraft, the 1-step procedure, and the 2-step procedure.

The 1-step procedure does the de-icing and anti-icing operations together. The anti-icing fluid is mixed with water in reference to ambient temperature, weather conditions, and holdover time.

The 2-step procedure is a de-icing and anti-icing step which are done one after the other. The de-icing step is done with hot water, or a hot mixture of de-icing fluid and water in reference to ambient temperature or by using infrared energy. The anti-icing step follows, and is an overspray mixture of anti-icing fluid and water, or a concentration of anti-icing fluid. The 2-step procedure is also done in reference to ambient temperature, weather conditions, and holdover time.

NOTE: If the APU shuts down due to a high EGT condition, check the APU inlet screen for ice build-up and all APU intake ducts for signs of collapse.

2. Parking Aircraft in Cold Weather

A. General

When parking aircraft under icing conditions, observe the following in addition to normal parking procedures outlined in Chapter 10.

(1) Clear snow, slush and ice from area in which aircraft is to be parked.

NOTE: If this is impractical, reduce possibility of tires being frozen to ground by cleaning area around wheels only.

(2) Examine the engine intake and exhaust areas for snow, frost, or ice.

CAUTION: DO NOT USE HARD OR SHARP TOOLS TO REMOVE ICE OR SNOW FROM THE AIRCRAFT SURFACES, YOU CAN CAUSE DAMAGE TO THE AIRCRAFT.

(3) Remove all the snow, frost, or ice from the intake and exhaust areas.

(4) Install all plugs and covers provided for aircraft, i.e., the engine and APU covers, the wheel covers, the static ports, the pitot heads, etc. (refer to Chapter 10).

NOTE: In extremely cold weather, prevent covers from freezing to aircraft by applying a light brush coat of de-icing fluid, Specification MIL-A-8243, or equivalent to mating surfaces.

3. Snow Removal

A. Remove Snow

Equipment and Material

Long-handled broom - Commercially available

Pneumatic starter cart - Commercially available

CAUTION: DO NOT USE HARD OR SHARP TOOLS TO REMOVE ICE OR SNOW FROM THE AIRCRAFT SURFACES, YOU CAN CAUSE DAMAGE TO THE AIRCRAFT.

(1) Immediately after snowfall, clean aircraft to prevent melting snow from freezing to surfaces and/or entering interior areas of aircraft.

WARNING: EXERCISE EXTREME CARE WHEN WALKING ON AIRCRAFT SURFACES TO AVOID SLIPPING OR SLIDING. PERSONNEL INJURIES CAN OCCUR.

CAUTION: BE AWARE OF NO STEP AREAS ON THE WING AND ENGINE PYLON AREAS TO PREVENT DAMAGE TO AIRCRAFT (REFER TO CHAPTER 11).

(2) Wet snow can best be removed using a long-handled broom and working from support stands placed close to aircraft. If stands are not available, wear rubber or fabric footwear.

(3) If snow accumulation is dry and light, blow the snow from aircraft using compressed air from pneumatic starter cart.

(4) Extend flaps (refer to Chapter 27).

(5) Manually remove all the snow from the components/areas that follow:

- Pitot/static probes

- Total air temperature (TAT) probes
- AOA Vanes
- Static ports
- Antennas
- Door sills and surrounds
- Fuselage
- Upper and lower wing surfaces
- Fuel drains/vents
- Leading edge of the wings
- Flight control shrouds
- Flight control hinges
- Flaps
- Engine intake and exhaust ports
- Landing gears
- Landing gear doors
- Landing gear bays
- RAM air intake
- APU inlet and exhaust areas
- Waste water and condensation drains

(6) Retract flaps (refer to Chapter 27).

(7) Check for snow accumulation between aileron and elevator leading edges and shrouds.

CAUTION: EXCESSIVE TEMPERATURES IN THE WINDSHIELD MAY RESULT IN PERMANENT DAMAGE.

(8) Clear a light accumulation of snow from the windshield, by setting the WSHLD heat switch on the overhead anti-ice panel to the LOW setting.

NOTE: If the windshield's temperature sensor area is heavily covered with snow, ground de-icing equipment is to be used.

(9) Do the de-icing/anti-icing procedure as required (refer to paragraph 4.C. or 4.D.)

4. Aircraft De-Icing/Anti-Icing, General Precautions (Figure 1 and Figure 2)

A. General Precautions

WARNING: IF YOU OPERATE THE ENGINES WHILE DOING THE DE-ICING/ANTI-ICING PROCEDURE, MAKE SURE ALL GROUND PERSONNEL ARE FAMILIAR WITH DANGER AREAS PARTICULAR TO THIS AIRCRAFT.

CAUTION: WHEN DE-ICING NEAR THE ENGINE AND APU INTAKES AND EXHAUSTS, BE CAREFUL TO PREVENT THE BUILD-UP OF DE-ICING FLUID WHICH MIGHT BE INGESTED AND IGNITED DURING THE ENGINES OR APU START. REMOVE ANY DE-ICING FLUID BUILD-UP BEFORE STARTING THE ENGINES OR THE APU.

MAKE SURE THAT APU IS NOT RUNNING WHEN YOU DO THE DE-ICING/ANTI-ICING PROCEDURE. DAMAGE TO COMPONENTS COULD OCCUR.

MAKE SURE THAT ALL OF THE BLEED AIR SOURCES ARE CLOSED WHEN YOU DO THE DE-ICING/ANTI-ICING PROCEDURE WITH THE ENGINES IN OPERATION. DAMAGE TO COMPONENTS COULD OCCUR.

NOTE: If you operate the engines while doing the de-icing/anti-icing procedure, do not permit fluid to go into engines.

If direct spraying occurs to the engine(s), wash both engines upon return to maintenance base.

(1) Extend flaps (refer to Chapter 27).

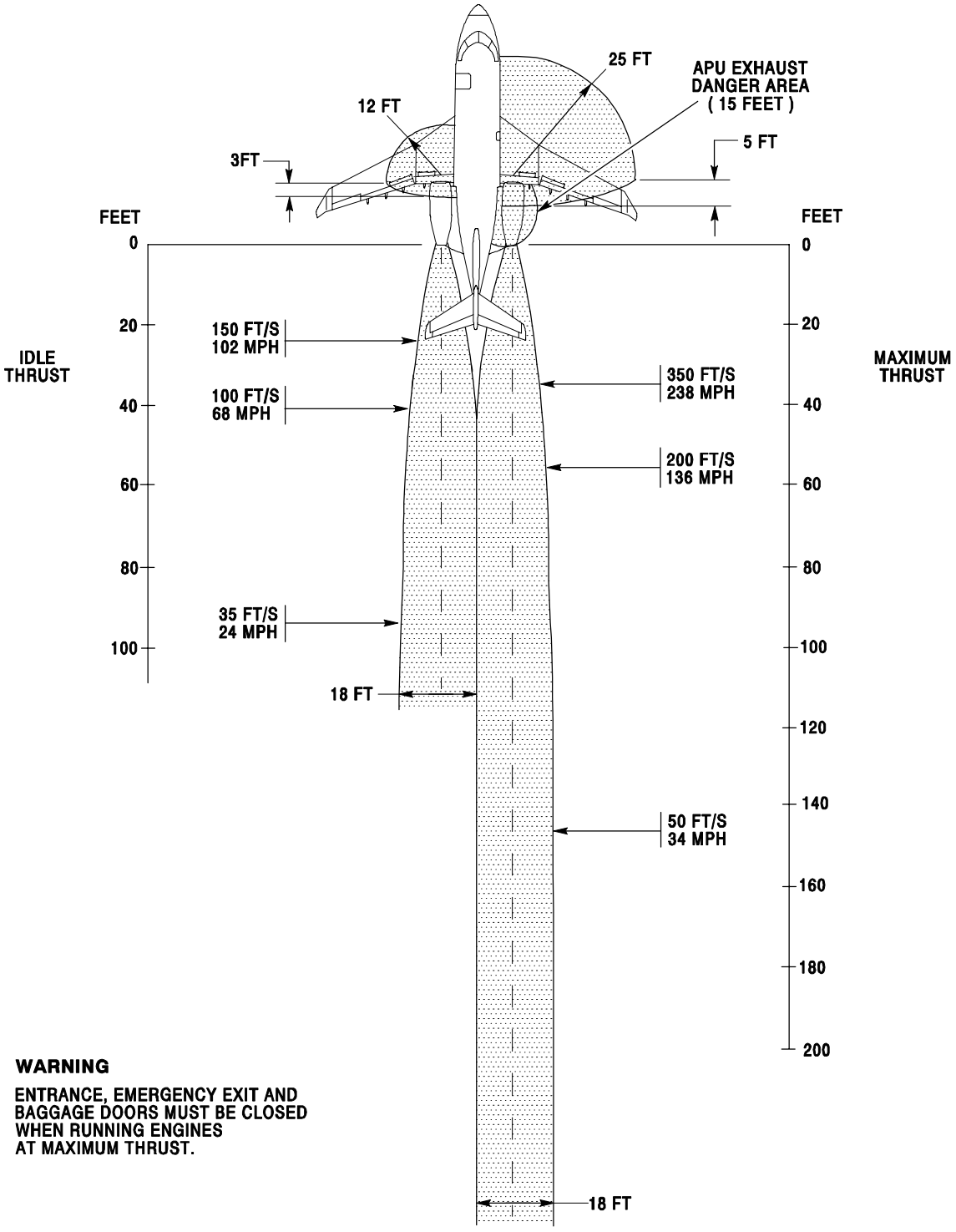
(2) Plug engine and APU air intakes and exhaust ducts if you do not need the engines running during de-icing.

CAUTION: DO NOT USE METALLIC OR SHARP TOOLS FOR REMOVING SNOW OR ICE. USE DE-ICING FLUID SPARINGLY AROUND HINGE POINTS AND BEARINGS; DO NOT SPRAY DIRECTLY ON THESES AREAS.

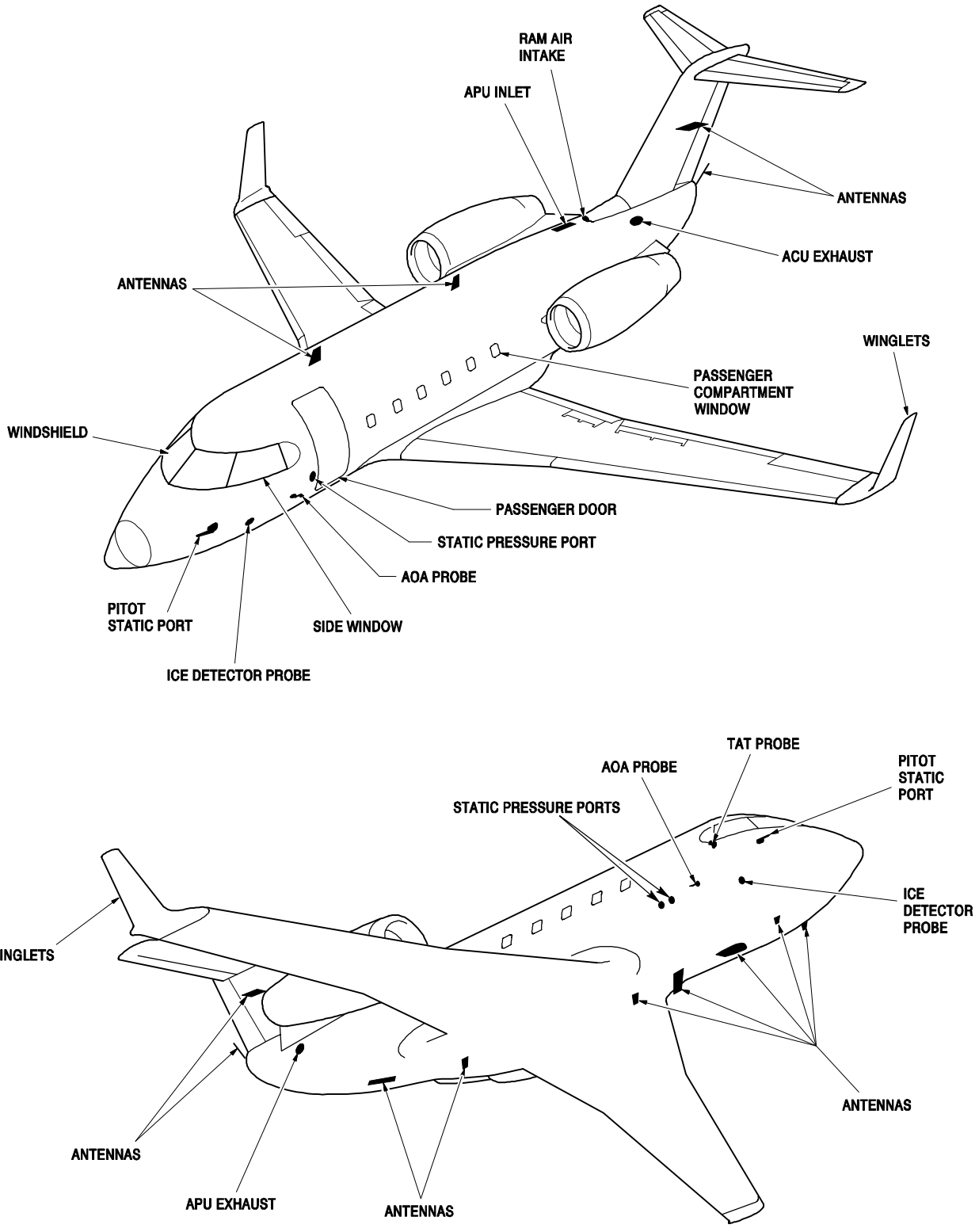
(a) Remove the snow, frost, or ice from the door sills and the door surrounds before the doors are closed.

(b) Do not spray de-icing/anti-icing fluid directly at or into the components/areas that follow:

- Windshields
- Side Windows
- Cabin windows



Aircraft Danger Areas
Figure 1



De-Icing/Anti-Icing Precaution Areas
Figure 2

- Pitot/static probes
- Total air temperature (TAT) probes
- AOA vanes
- Static ports
- Antennas
- Door sills and surrounds
- Door handles
- Fuel vents
- Engine air intake and exhaust
- ACU exhaust port
- RAM air intake
- APU inlet and exhaust areas
- Waste water and condensation drains
- Brakes/wheels

(c) Do not spray fluid directly into the wind.

(d) Spray on the highest point to allow fluid to work down the surface.

(e) Keep the spray distance as short as possible.

(f) When de-icing the control surfaces, make sure that the ice/snow is not pushed between the leading edge of the control surface and its adjacent shroud.

(3) Drain holes, static ports, pitot heads, retraction mechanisms and control surfaces must be free of ice accumulation. Remove excessive ice build-up on flap actuators and vane shafts by spray application of de-icing fluid.

(4) Remove ice from aircraft surface by spray application of de-icing fluid and, as ice loosens, sweep it off.

NOTE: Hot air may also be used to melt ice except by direct application to window surfaces. Melting ice must be mopped dry to prevent subsequent freezing.

CAUTION: EXCESSIVE TEMPERATURES IN THE WINDSHIELD MAY RESULT IN PERMANENT DAMAGE.

IF THE WINDSHIELD'S TEMPERATURE SENSOR AREA IS HEAVILY COVERED WITH ICE, GROUND DE-ICING EQUIPMENT IS TO BE USED TO PREVENT DAMAGE TO WINDSHIELDS.

(5) Clear a light buildup of ice from the windshield, by setting the WSHLD heat switch on the overhead anti-ice panel to the LOW setting.

(6) Retract flaps (refer to Chapter 27).

(7) You can use infrared energy as an alternative procedure to remove frozen precipitation (de-icing). It is done through heat that breaks the bond of adhering contamination. The application of infrared energy may be continued to melt and evaporate frozen contaminants.

WARNING: WHEN USING INFRARED ENERGY TO DE-ICE, WET SURFACES REQUIRE AN APPLICATION OF HEATED DE-ICING FLUIDS TO PREVENT REFREEZING AFTER REMOVAL OF INFRARED ENERGY SOURCE. FAILURE TO DO THIS MAY CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.

WARNING: WHEN REQUIRED, FOR OPERATION OTHER THAN FROST OR LEADING EDGE ICE REMOVAL, AND WHEN OAT IS AT OR BELOW 32°F (0°C), AN ADDITIONAL TREATMENT WITH HOT DE-ICING FLUID MUST BE DONE WITHIN THE INFRARED DE-ICING FACILITY TO PREVENT REFREEZING OF WATER WHICH MAY REMAIN IN HIDDEN AREAS. FAILURE TO DO THIS MAY CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.

CAUTION: IF THE AIRCRAFT REQUIRES DE-ICING AGAIN AND DE-ICING/ANTI-ICING FLUIDS HAD BEEN APPLIED BEFORE FLIGHT, CONVENTIONAL DE-ICING/ANTI-ICING WITH FLUIDS MUST BE DONE. FAILURE TO DO THIS MAY CAUSE DAMAGE TO EQUIPMENT.

(a) When you use infrared energy to de-ice, refer also to the following SAE industry standards practices and FAA Advisory Circulars for procedures and precautions:

- SAE Aerospace Recommended Practices ARP 4737,
- FAA Advisory Circular No: 150/5300-14 Appendix A,
- FAA Advisory Circular No: 120-89.

B. De-Icing/Anti-Icing Fluids

(1) Type I De-Icing Fluids

In concentrated form, these fluids contain glycols to a minimum concentration of 80%, but no thickening agents. Their low viscosity results in very short holdover times that limit them for use as de-icing agents only.

(2) Type II, Type III, or Type IV De-Icing/Anti-Icing Fluids

These fluids contain glycol to a minimum concentration of 50% as well as thickening agents. Their relatively high viscosity permits the application of a layer of fluid that is effective in de-icing and persists as a useful holdover time to provide anti-icing. During take-off, the slipstream imparts a shear stress to the fluid layer which reduces its viscosity and allows it to flow off the surface to which it was applied.

C. Aircraft De-Icing/Anti-Icing, 1-step Procedure

Equipment and Material

Truck, aircraft de-icing - Commercially available

Goggles - Commercially available

Gloves - Commercially available

Anti-icing and de-icing fluid - Specification MIL-A-8243, or equivalent (SAE Type I, Type II, Type III, or Type IV)

WARNING: IF YOU OPERATE THE ENGINES WHILE DOING THE DE-ICING/ANTI-ICING PROCEDURE, MAKE SURE ALL GROUND PERSONNEL ARE FAMILIAR WITH DANGER AREAS PARTICULAR TO THIS AIRCRAFT.

CAUTION: WHEN DE-ICING NEAR THE ENGINE AND APU INTAKES AND EXHAUSTS, BE CAREFUL TO PREVENT THE BUILD-UP OF DE-ICING FLUID WHICH MIGHT BE INGESTED AND IGNITED DURING THE ENGINES OR APU START. REMOVE ANY DE-ICING FLUID BUILD-UP BEFORE STARTING THE ENGINES OR THE APU.

MAKE SURE THAT APU IS NOT RUNNING WHEN YOU DO THE DE-ICING/ANTI-ICING PROCEDURE. DAMAGE TO COMPONENTS COULD OCCUR.

MAKE SURE THAT ALL OF THE BLEED AIR SOURCES ARE CLOSED WHEN YOU DO THE DE-ICING/ANTI-ICING PROCEDURE WITH THE ENGINES IN OPERATION. DAMAGE TO COMPONENTS COULD OCCUR.

(1) Extend flaps (refer to Chapter 27).

(2) Observe all of the general precautions (refer to paragraph 4.A.).

(3) Manually remove all the snow, or ice from the aircraft surfaces (refer to paragraph 3.A.).

WARNING: WEAR GOGGLES AND PROTECTIVE CLOTHING WHEN YOU USE DE-ICING/ANTI-ICING FLUID. DE-ICING/ANTI-ICING FLUID MIXTURES ARE POISONOUS.

(4) Apply de-icing/anti-icing fluid or mixtures as required. Refer to the following tables for mixing de-icing/anti-icing fluid and for holdover times.

NOTE: If you operate the engines while doing the de-icing/anti-icing procedure, do not permit fluid to go into engines.

If direct spraying occurs to the engine(s), wash both engines upon return to maintenance base (refer to ALF 502L Engine Maintenance Manual).

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

GUIDELINE TO APPLY SAE TYPE I FLUID MIXTURES (MINIMUM CONCENTRATIONS) AS A FUNCTION OF OUTSIDE AIR TEMPERATURE (OAT)		
OAT ˚F	OAT ˚C	AIRCRAFT DE-ICING/ANTI-ICING, 1-STEP PROCEDURE
27 and above	-3 and above	The freezing point of the fluid mixture should be at least 18˚F (10˚C) or more below OAT
below 27	below -3	

NOTE: A fluid temperature of not less than 140˚F (60˚C) at the nozzle is necessary.

The freezing point of the SAE Type I fluid mixture must be 18˚F (10˚C) or more below the outside air temperature (OAT).

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

THE ONLY ACCEPTABLE DECISION CRITERIA TIME IS THE SHORTEST TIME WITHIN THE APPLICABLE HOLDOVER TIME TABLE CELL.

THE USE OF ANTI-ICING FLUIDS DURING GROUND DE-ICING DO NOT GIVE ICE PROTECTION DURING FLIGHT.

GUIDELINE FOR HOLDOVER TIMES ESTIMATED FOR SAE TYPE I FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE (OAT)

OAT		APPROXIMATE HOLDOVER TIMES FOR DIFFERENT WEATHER CONDITIONS (ALL DELAY TIMES ARE IN MINUTES UNLESS SPECIFIED IN HOURS)							
˚F	˚C	FROST [1]	FREEZING FOG	VERY LIGHT SNOW [3]	LIGHT SNOW [3] [4]	MODERATE SNOW [3]	FREEZING DRIZZLE [2]	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
27 and above	−3 and above	45	11 to 17	18	11 to 18	6 to 11	9 to 13	4 to 6	2 to 5
below 27 to 21	below −3 to −6	45	8 to 13	14	8 to 14	5 to 8	5 to 9	4 to 6	–
below 21 to 14	below −6 to −10	45	6 to 10	11	6 to 11	4 to 6	4 to 7	2 to 5	–
below 14	below −10	45	5 to 9	7	4 to 7	2 to 4	–		

NOTE: The holdover times shown in this table are for general data functions only. Use the holdover times with a pre-takeoff inspection.

The holdover times will decrease in heavy weather conditions. High winds, jet blast, and prop wash can also degrade the protective film. If these conditions occur, the holdover times can be much shorter. This also applies when the fuel temperature is lower than the outside air temperature (OAT).

The holdover times start when de-icing/anti-icing procedure starts.

The freezing point of the SAE Type I fluid mixture must be 10˚C (18˚F) or more below the outside air temperature (OAT).

[1] During conditions that apply to aircraft protection for ACTIVE FROST.

[2] If positive identification of freezing drizzle is not possible, use the light freezing rain holdover time.

[3] To use these times, heat the fluid to get a minimum of 60˚C (140˚F) at the nozzle. Apply the fluid to the de-iced surfaces at an average rate of at least 1 L/m^2 (2 $gals/100ft^2$).

[4] The light snow range is based on precipitation rates from 1.0 mm/hr to 0.3 mm/hr (0.04 in/hr to 0.01 in/hr) liquid water equivalent.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

MAKE SURE SUFFICIENT AMOUNT OF ANTI-ICING FLUID IS USED FOR THE DE-ICING AND ANTI-ICING STEPS. NOT ENOUGH ANTI-ICING FLUID MAY CAUSE A SUBSTANTIAL LOSS OF HOLDOVER TIME.

GUIDELINE TO APPLY SAE TYPE II, TYPE III, OR IV FLUID MIXTURES (MINIMUM CONCENTRATIONS) AS A FUNCTION OF OUTSIDE AIR TEMPERATURE (OAT)		
CONCENTRATION, HEATED - FLUID/WATER RATIO (VOL %/VOL %)		
OAT ˚F	OAT ˚C	AIRCRAFT DE-ICING/ANTI-ICING, 1-STEP PROCEDURE
27 and above	-3 and above	50/50 Heated, Type II/III/IV
7 and above	-14 and above	75/25 Heated, Type II/III/IV
-13 and above	-25 and above	100/0 Heated, Type II/III/IV
below -13	below -25	SAE Type II, Type III, and IV fluid may be used below -25˚C (-13˚F), provided that the freezing point of the fluid is at least 7˚C (14˚F) below OAT. Use SAE Type I fluid when Type II, Type III, and IV fluid cannot be used.

NOTE: A fluid temperature of not less than 140˚F (60˚C) at the nozzle is necessary.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

THE ONLY ACCEPTABLE DECISION CRITERIA TIME IS THE SHORTEST TIME WITHIN THE APPLICABLE HOLDOVER TIME TABLE CELL.

THE USE OF ANTI-ICING FLUIDS DURING GROUND DE-ICING DO NOT GIVE ICE PROTECTION DURING FLIGHT.

GUIDELINE FOR HOLDOVER TIMES ESTIMATED FOR SAE TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE (OAT)

OAT		APPROXIMATE HOLDOVER TIMES FOR DIFFERENT WEATHER CONDITIONS (ALL DELAY TIMES ARE IN MINUTES UNLESS SPECIFIED IN HOURS)						
˚F	˚C	CONCENTRATION OF FLUID/WATER (VOL%/VOL%)	FROST [1]	FREEZING FOG	SNOW	FREEZING DRIZZLE [3]	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
above 32	above 0	100/0	12 hrs	35 to 90	20 to 55	30 to 55	15 to 30	5 to 40
		75/25	6 hrs	25 to 60	15 to 40	20 to 45	10 to 25	5 to 25
		50/50	4 hrs	15 to 30	5 to 15	5 to 15	5 to 10	–
32 to 27	0 to -3	100/0	8 hrs	35 to 90	20 to 45	30 to 55	15 to 30	–
		75/25	5 hrs	25 to 60	15 to 30	20 to 45	10 to 25	–
		50/50	3 hrs	15 to 30	5 to 15	5 to 15	5 to 10	–
below 27 to 7	below -3 to -14	100/0	8 hrs	20 to 65	15 to 35	15 to 45 [2]	10 to 25 [2]	–
		75/25	5 hrs	20 to 55	15 to 25	15 to 30 [2]	10 to 20 [2]	–
below 7 to -13	below -14 to -25	100/0	8 hrs	15 to 20	15 to 30	–	–	–
below -13	below -25	100/0	SAE Type II fluid may be used below -25˚C (-13˚F) provided the freezing point of the fluid is at least 7˚C (13˚F) below the OAT. Use SAE Type I when SAE Type II fluid cannot be used.					

NOTE: The holdover times shown in this table are for general data functions only. Use the holdover times with a pre-takeoff inspection.

The holdover times will decrease in heavy weather conditions. High winds, jet blast, and prop wash can also degrade the protective film. If these conditions occur, the holdover times can be much shorter. This also applies when the fuel temperature is lower than the outside air temperature (OAT).

The holdover times start when de-icing/anti-icing procedure starts.

[1] During conditions that apply to aircraft protection for ACTIVE FROST.

[2] The lowest use temperature is limited to -10˚C (14˚F).

[3] If positive identification of the freezing drizzle is not possible, use the light freezing rain holdover times.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

THE ONLY ACCEPTABLE DECISION CRITERIA TIME IS THE SHORTEST TIME WITHIN THE APPLICABLE HOLDOVER TIME TABLE CELL.

THE USE OF ANTI-ICING FLUIDS DURING GROUND DE-ICING DO NOT GIVE ICE PROTECTION DURING FLIGHT.

GUIDELINE FOR HOLDOVER TIMES ESTIMATED FOR SAE TYPE III FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE (OAT)

OAT		APPROXIMATE HOLDOVER TIMES FOR DIFFERENT WEATHER CONDITIONS (ALL DELAY TIMES ARE IN MINUTES UNLESS SPECIFIED IN HOURS)							
°F	°C	ACTIVE FROST	FREEZING FOG	VERY LIGHT SNOW [1]	LIGHT SNOW [1]	MODERATE SNOW [1]	FREEZING DRIZZLE [2]	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
27 and above	−3 and above	2 hrs	20 to 40	35	20 to 35	15 to 20	10 to 20	8 to 10	6 to 20
below 27 to 14	below −3 to −10	2 hrs	20 to 40	30	15 to 30	9 to 15	10 to 20	8 to 10	–
below 14	below −10	2 hrs	20 to 40	30	15 to 30	8 to 15	–	–	–

NOTE: The holdover times shown in this table are for general data functions only. Use the holdover times with a pre-takeoff inspection.

The holdover times will decrease in heavy weather conditions. High winds, jet blast, and prop wash can also degrade the protective film. If these conditions occur, the holdover times can be much shorter. This also applies when the fuel temperature is lower than the outside air temperature (OAT).

The holdover times start when de-icing/anti-icing procedure starts.

Use SAE Type I when SAE Type III fluid cannot be used.

[1] Snow includes snow grains.

[2] If positive identification of the freezing drizzle is not possible, use the light freezing rain holdover times.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

THE ONLY ACCEPTABLE DECISION CRITERIA TIME IS THE SHORTEST TIME WITHIN THE APPLICABLE HOLDOVER TIME TABLE CELL.

THE USE OF ANTI-ICING FLUIDS DURING GROUND DE-ICING DO NOT GIVE ICE PROTECTION DURING FLIGHT.

GUIDELINE FOR HOLDOVER TIMES ESTIMATED FOR SAE TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE (OAT)

OAT		APPROXIMATE HOLDOVER TIMES FOR DIFFERENT WEATHER CONDITIONS (ALL DELAY TIMES ARE IN MINUTES UNLESS SPECIFIED IN HOURS)						
°F	°C	CONCENTRATION OF FLUID/WATER (VOL%/VOL%)	FROST [1]	FREEZING FOG	SNOW	FREEZING DRIZZLE [3]	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
above 32	above 0	100/0	18 hrs	65 to 135	35 to 65	40 to 70	25 to 40	10 to 50
		75/25	6 hrs	65 to 105	30 to 65	35 to 50	15 to 30	5 to 35
		50/50	4 hrs	15 to 35	5 to 20	10 to 20	5 to 10	
32 to 27	0 to -3	100/0	12 hrs	65 to 135	30 to 55	40 to 70	25 to 40	-
		75/25	5 hrs	65 to 105	25 to 50	35 to 50	15 to 30	-
		50/50	3 hrs	15 to 35	5 to 15	10 to 20	5 to 10	-
below 27 to 7	below -3 to -14	100/0	12 hrs	20 to 80	20 to 40	20 to 45 [2]	10 to 25 [2]	-
		75/25	5 hrs	25 to 50	20 to 35	15 to 30 [2]	10 to 20 [2]	-
below 7 to -13	below -14 to -25	100/0	12 hrs	15 to 40	15 to 30	-	-	-
below -13	below -25	100/0	SAE Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at 7°C (13°F) minimum below the OAT. Use SAE Type I when SAE Type IV fluid cannot be used.					

NOTE: The holdover times shown in this table are for general data functions only. Use the holdover times with a pre-takeoff inspection.

The holdover times will decrease in heavy weather conditions. High winds, jet blast, and prop wash can also degrade the protective film. If these conditions occur, the holdover times can be much shorter. This also applies when the fuel temperature is lower than the outside air temperature (OAT).

The holdover times start when de-icing/anti-icing procedure starts.

[1] During conditions that apply to aircraft protection for ACTIVE FROST.

[2] The lowest use temperature is limited to -10°C (14°F).

[3] If positive identification of the freezing drizzle is not possible, use the light freezing rain holdover times.

(5) Do a visual inspection of the components/areas that follow:

(a) Make sure that the pitot/static tubes, total air temperature probes and the static pressure ports are clear of snow, frost or ice.

(b) Make sure that all the doors are clear of snow, frost or ice.

(c) Make sure that all the flight control surfaces are clear of snow, frost or ice.

(d) Make sure that the aerodynamic seals for the primary flight controls are clear of snow, frost or ice.

(e) Make sure that the main and nose landing gears and bays are clear of snow, frost or ice.

(f) Make sure that the APU, engine intakes and exhausts are clear of snow, frost or ice.

(g) Make sure that all the inlets and drains are clear of snow, frost or ice.

(h) Type II and type IV fluids may thicken and dry out in the quiet areas and crevices of the aircraft surfaces. Remove the unwanted fluids from the quiet areas and crevices of the aircraft surfaces before departure.

(6) Remove all tools, equipment, and unwanted materials from the work area.

(7) Retract flaps (refer to Chapter 27).

D. Aircraft De-Icing/Anti-Icing, 2-step Procedure

Equipment and Material

Truck, aircraft de-icing - Commercially available

Goggles - Commercially available

Gloves - Commercially available

Anti-icing and de-icing fluid - Specification MIL-A-8243, or equivalent (SAE Type I, Type II, Type III, or Type IV)

WARNING: IF YOU OPERATE THE ENGINES WHILE DOING THE DE-ICING/ANTI-ICING PROCEDURE, MAKE SURE ALL GROUND PERSONNEL ARE FAMILIAR WITH DANGER AREAS PARTICULAR TO THIS AIRCRAFT.

CAUTION: WHEN DE-ICING NEAR THE ENGINE AND APU INTAKES AND EXHAUSTS, BE CAREFUL TO PREVENT THE BUILD-UP OF DE-ICING FLUID WHICH MIGHT BE INGESTED AND IGNITED DURING THE ENGINES OR APU START. REMOVE ANY DE-ICING FLUID BUILD-UP BEFORE STARTING THE ENGINES OR THE APU.

MAKE SURE THAT APU IS NOT RUNNING WHEN YOU DO THE DE-ICING/ANTI-ICING PROCEDURE. DAMAGE TO COMPONENTS COULD OCCUR.

MAKE SURE THAT ALL OF THE BLEED AIR SOURCES ARE CLOSED WHEN YOU DO THE DE-ICING/ANTI-ICING PROCEDURE WITH THE ENGINES IN OPERATION. DAMAGE TO COMPONENTS COULD OCCUR.

(1) Extend flaps (refer to Chapter 27).

(2) Observe all of the general precautions (refer to paragraph 4.A.)

(3) Manually remove all the snow, or ice from the aircraft surfaces (refer to paragraph 3.A.)

WARNING: WEAR GOGGLES AND PROTECTIVE CLOTHING WHEN YOU USE DE-ICING/ANTI-ICING FLUID. DE-ICING/ANTI-ICING FLUID MIXTURES ARE POISONOUS.

(4) Apply de-icing/anti-icing fluid or mixtures as required. Refer to the following tables for mixing de-icing/anti-icing fluid and for holdover times.

NOTE: If you operate the engines while doing the de-icing/anti-icing procedure, do not permit fluid to go into engines.

If direct spraying occurs to the engine(s), wash both engines upon return to maintenance base.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

GUIDELINE TO APPLY SAE TYPE I FLUID MIXTURES (MINIMUM CONCENTRATIONS) AS A FUNCTION OF OUTSIDE AIR TEMPERATURE (OAT)

OAT ˚F	OAT ˚C	AIRCRAFT DE-ICING/ANTI-ICING, 2-STEP PROCEDURE	
		DE-ICING STEP	ANTI-ICING STEP
27 and above	-3 and above	Water heated to 140˚F (60˚C) minimum at the nozzle or a heated mixture fluid and water	Freezing point of fluid mixture shall be at least 18˚F (10˚C) below actual OAT
below 27	below -3	Freezing point of heated fluid mixture shall not be more than 5˚F (3˚C) above actual OAT	

NOTE: A fluid temperature of not less than 140˚F (60˚C) at the nozzle is necessary.

The freezing point of the SAE Type I fluid mixture must be 18˚F (10˚C) or more below the outside air temperature (OAT).

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

THE ONLY ACCEPTABLE DECISION CRITERIA TIME IS THE SHORTEST TIME WITHIN THE APPLICABLE HOLDOVER TIME TABLE CELL.

THE USE OF ANTI-ICING FLUIDS DURING GROUND DE-ICING DO NOT GIVE ICE PROTECTION DURING FLIGHT.

GUIDELINE FOR HOLDOVER TIMES ESTIMATED FOR SAE TYPE I FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE (OAT)

OAT		APPROXIMATE HOLDOVER TIMES FOR DIFFERENT WEATHER CONDITIONS (ALL DELAY TIMES ARE IN MINUTES UNLESS SPECIFIED IN HOURS)							
˚F	˚C	FROST [1]	FREEZING FOG	VERY LIGHT SNOW [3]	LIGHT SNOW [3] [4]	MODERATE SNOW [3]	FREEZING DRIZZLE [2]	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
27 and above	−3 and above	45	11 to 17	18	11 to 18	6 to 11	9 to 13	4 to 6	2 to 5
below 27 to 21	below −3 to −6	45	8 to 13	14	8 to 14	5 to 8	5 to 9	4 to 6	–
below 21 to 14	below −6 to −10	45	6 to 10	11	6 to 11	4 to 6	4 to 7	2 to 5	–
below 14	below −10	45	5 to 9	7	4 to 7	2 to 4	–		

NOTE: The holdover times shown in this table are for general data functions only. Use the holdover times with a pre-takeoff inspection.

The holdover times will decrease in heavy weather conditions. High winds, jet blast, and prop wash can also degrade the protective film. If these conditions occur, the holdover times can be much shorter. This also applies when the fuel temperature is lower than the outside air temperature (OAT).

The holdover times start when de-icing/anti-icing procedure starts.

The freezing point of the SAE Type I fluid mixture must be 10˚C (18˚F) or more below the outside air temperature (OAT).

[1] During conditions that apply to aircraft protection for ACTIVE FROST.

[2] If positive identification of freezing drizzle is not possible, use the light freezing rain holdover time.

[3] To use these times, heat the fluid to get a minimum of 60˚C (140˚F) at the nozzle. Apply the fluid to the de-iced surfaces at an average rate of at least 1 L/m^2 (2 $gals/100ft^2$).

[4] The light snow range is based on precipitation rates from 1.0 mm/hr to 0.3 mm/hr (0.04 in/hr to 0.01 in/hr) liquid water equivalent.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

MAKE SURE SUFFICIENT AMOUNT OF ANTI-ICING FLUID IS USED FOR THE DE-ICING AND ANTI-ICING STEPS. NOT ENOUGH ANTI-ICING FLUID MAY CAUSE A SUBSTANTIAL LOSS OF HOLDOVER TIME.

GUIDELINE TO APPLY SAE TYPE II, TYPE III, OR TYPE IV FLUID MIXTURES (MINIMUM CONCENTRATIONS) AS A FUNCTION OF OUTSIDE AIR TEMPERATURE (OAT)			
HEATED CONCENTRATION OF FLUID/WATER RATIO (VOL %/VOL %)			
OAT °F	OAT °C	AIRCRAFT DE-ICING/ANTI-ICING, 2-STEP PROCEDURE	
		DE-ICING STEP	ANTI-ICING STEP
27 and above	-3 and above	Water heated to 60°C (140°F) minimum at the nozzle or a heated mixture of Type I, Type II, Type III, or IV and water	(50/50) Type II/III/IV
7 and above	-14 and above	Heated suitable mix of Type I, Type II, Type III, or Type IV and water with freezing point not more than 3°C (5°F) above actual OAT	(75/25) Type II/III/IV
-13 and above	-25 and above	Heated suitable mix of Type I, Type II, Type III, or Type IV and water with freezing point not more than 3°C (5°F) above actual OAT	(100/0) Type II/III/IV
below -13	below -25	SAE Type II, Type III, and Type IV fluids may be used below -25°C (-13°F) provided that the freezing point of the fluid is at least 7°C (14°F) below OAT. Use SAE Type I when SAE Type II, Type III, and Type IV cannot be used.	

NOTE: A fluid temperature of not less than 140°F (60°C) at the nozzle is necessary.

Whenever frost or ice occurs on the lower surface of the wing in the area of the fuel tank, indicating a cold soaked wing, the 50/50 dilutions for Type II, Type III, or Type IV should not be used for the anti-icing step because fluid freezing may occur.

Make sure to use proper amount of anti-icing fluid. Insufficient amount of anti-icing fluid may cause a substantial loss of holdover time, particularly when using Type I fluid mixture for the first step in a two-step procedure.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

THE ONLY ACCEPTABLE DECISION CRITERIA TIME IS THE SHORTEST TIME WITHIN THE APPLICABLE HOLDOVER TIME TABLE CELL.

THE USE OF ANTI-ICING FLUIDS DURING GROUND DE-ICING DO NOT GIVE ICE PROTECTION DURING FLIGHT.

GUIDELINE FOR HOLDOVER TIMES ESTIMATED FOR SAE TYPE II FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE (OAT)

OAT		APPROXIMATE HOLDOVER TIMES FOR DIFFERENT WEATHER CONDITIONS (ALL DELAY TIMES ARE IN MINUTES UNLESS SPECIFIED IN HOURS)						
˚F	˚C	CONCENTRATION OF FLUID/WATER (VOL%/VOL%)	FROST [1]	FREEZING FOG	SNOW	FREEZING DRIZZLE [3]	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
above 32	above 0	100/0	12 hrs	35 to 90	20 to 55	30 to 55	15 to 30	5 to 40
		75/25	6 hrs	25 to 60	15 to 40	20 to 45	10 to 25	5 to 25
		50/50	4 hrs	15 to 30	5 to 15	5 to 15	5 to 10	–
32 to 27	0 to −3	100/0	8 hrs	35 to 90	20 to 45	30 to 55	15 to 30	–
		75/25	5 hrs	25 to 60	15 to 30	20 to 45	10 to 25	–
		50/50	3 hrs	15 to 30	5 to 15	5 to 15	5 to 10	–
below 27 to 7	below −3 to −14	100/0	8 hrs	20 to 65	15 to 35	15 to 45 [2]	10 to 25 [2]	–
		75/25	5 hrs	20 to 55	15 to 25	15 to 30 [2]	10 to 20 [2]	–
below 7 to −13	below −14 to −25	100/0	8 hrs	15 to 20	15 to 30	–	–	–
below −13	below −25	100/0	SAE Type II fluid may be used below −25˚C (−13˚F) provided the freezing point of the fluid is at least 7˚C (13˚F) below the OAT. Use SAE Type I when SAE Type II fluid cannot be used.					

NOTE: The holdover times shown in this table are for general data functions only. Use the holdover times with a pre-takeoff inspection.

The holdover times will decrease in heavy weather conditions. High winds, jet blast, and prop wash can also degrade the protective film. If these conditions occur, the holdover times can be much shorter. This also applies when the fuel temperature is lower than the outside air temperature (OAT).

The holdover times start when de-icing/anti-icing procedure starts.

[1] During conditions that apply to aircraft protection for ACTIVE FROST.

[2] The lowest use temperature is limited to −10˚C (14˚F).

[3] If positive identification of the freezing drizzle is not possible, use the light freezing rain holdover times.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

THE ONLY ACCEPTABLE DECISION CRITERIA TIME IS THE SHORTEST TIME WITHIN THE APPLICABLE HOLDOVER TIME TABLE CELL.

THE USE OF ANTI-ICING FLUIDS DURING GROUND DE-ICING DO NOT GIVE ICE PROTECTION DURING FLIGHT.

GUIDELINE FOR HOLDOVER TIMES ESTIMATED FOR SAE TYPE III FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE (OAT)

OAT		APPROXIMATE HOLDOVER TIMES FOR DIFFERENT WEATHER CONDITIONS (ALL DELAY TIMES ARE IN MINUTES UNLESS SPECIFIED IN HOURS)							
°F	°C	ACTIVE FROST	FREEZING FOG	VERY LIGHT SNOW [1]	LIGHT SNOW [1]	MODERATE SNOW [1]	FREEZING DRIZZLE [2]	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
27 and above	−3 and above	2 hrs	20 to 40	35	20 to 35	15 to 20	10 to 20	8 to 10	6 to 20
below 27 to 14	below −3 to −10	2 hrs	20 to 40	30	15 to 30	9 to 15	10 to 20	8 to 10	–
below 14	below −10	2 hrs	20 to 40	30	15 to 30	8 to 15	–	–	–

NOTE: The holdover times shown in this table are for general data functions only. Use the holdover times with a pre-takeoff inspection.

The holdover times will decrease in heavy weather conditions. High winds, jet blast, and prop wash can also degrade the protective film. If these conditions occur, the holdover times can be much shorter. This also applies when the fuel temperature is lower than the outside air temperature (OAT).

The holdover times start when de-icing/anti-icing procedure starts.

Use SAE Type I when SAE Type III fluid cannot be used.

[1] Snow includes snow grains.

[2] If positive identification of the freezing drizzle is not possible, use the light freezing rain holdover times.

CAUTION: MAKE SURE THAT THE FREEZING POINT OF THE HEATED DE-ICING/ANTI-ICING FLUID MIXTURE IS SUFFICIENT TO REMOVE ALL ICE AND SNOW. THE AIRCRAFT SKIN TEMPERATURE AND THE OUTSIDE AIR TEMPERATURE CAN BE DIFFERENT.

THE ONLY ACCEPTABLE DECISION CRITERIA TIME IS THE SHORTEST TIME WITHIN THE APPLICABLE HOLDOVER TIME TABLE CELL.

THE USE OF ANTI-ICING FLUIDS DURING GROUND DE-ICING DO NOT GIVE ICE PROTECTION DURING FLIGHT.

GUIDELINE FOR HOLDOVER TIMES ESTIMATED FOR SAE TYPE IV FLUID MIXTURES AS A FUNCTION OF WEATHER CONDITIONS AND OUTSIDE AIR TEMPERATURE (OAT)

OAT		APPROXIMATE HOLDOVER TIMES FOR DIFFERENT WEATHER CONDITIONS (ALL DELAY TIMES ARE IN MINUTES UNLESS SPECIFIED IN HOURS)						
°F	°C	CONCENTRATION OF FLUID/WATER (VOL%/VOL%)	FROST [1]	FREEZING FOG	SNOW	FREEZING DRIZZLE [3]	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
above 32	above 0	100/0	18 hrs	65 to 135	35 to 65	40 to 70	25 to 40	10 to 50
		75/25	6 hrs	65 to 105	30 to 65	35 to 50	15 to 30	5 to 35
		50/50	4 hrs	15 to 35	5 to 20	10 to 20	5 to 10	
32 to 27	0 to -3	100/0	12 hrs	65 to 135	30 to 55	40 to 70	25 to 40	-
		75/25	5 hrs	65 to 105	25 to 50	35 to 50	15 to 30	-
		50/50	3 hrs	15 to 35	5 to 15	10 to 20	5 to 10	-
below 27 to 7	below -3 to -14	100/0	12 hrs	20 to 80	20 to 40	20 to 45 [2]	10 to 25 [2]	-
		75/25	5 hrs	25 to 50	20 to 35	15 to 30 [2]	10 to 20 [2]	-
below 7 to -13	below -14 to -25	100/0	12 hrs	15 to 40	15 to 30	-	-	-
below -13	below -25	100/0	SAE Type IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at 7°C (13°F) minimum below the OAT. Use SAE Type I when SAE Type IV fluid cannot be used.					

NOTE: The holdover times shown in this table are for general data functions only. Use the holdover times with a pre-takeoff inspection.

The holdover times will decrease in heavy weather conditions. High winds, jet blast, and prop wash can also degrade the protective film. If these conditions occur, the holdover times can be much shorter. This also applies when the fuel temperature is lower than the outside air temperature (OAT).

The holdover times start when de-icing/anti-icing procedure starts.

[1] During conditions that apply to aircraft protection for ACTIVE FROST.

[2] The lowest use temperature is limited to -10°C (14°F).

[3] If positive identification of the freezing drizzle is not possible, use the light freezing rain holdover times.

(5) Do a visual inspection of the components/areas that follow:

(a) Make sure that the pitot/static tubes, total air temperature probes and the static pressure ports are clear of snow, frost or ice.

(b) Make sure that all the doors are clear of snow, frost or ice.

(c) Make sure that all the flight control surfaces are clear of snow, frost or ice.

(d) Make sure that the aerodynamic seals for the primary flight controls are clear of snow, frost or ice.

(e) Make sure that the main and nose landing gears and bays are clear of snow, frost or ice.

(f) Make sure that the APU, engine intakes and exhausts are clear of snow, frost or ice.

(g) Make sure that all the inlets and drains are clear of snow, frost or ice.

(h) Type II and type IV fluids may thicken and dry out in the quiet areas and crevices of the aircraft surfaces. Remove the unwanted fluids from the quiet areas and crevices of the aircraft surfaces before departure.

(6) Remove all tools, equipment, and unwanted materials from the work area.

(7) Retract flaps (refer to Chapter 27).