ANTI-ICE/DEICE SYSTEMS

The anti-ice systems are designed to prevent ice formation on the pitot tubes, static ports, windshields, the angle-of-attack probe, the inboard wing leading edges and the engine inlet cowls, and to protect against engine ice damage. The various anti-icing functions use electrical power or engine bleed air and are actuated by switches on the left panel and control knobs on the copilot's panel. Anti-ice systems should be turned on when operating in visible moisture with an indicated OAT between +10°C and -30°C.

AIRPLANE ANTI-ICE/DEICE SYSTEMS

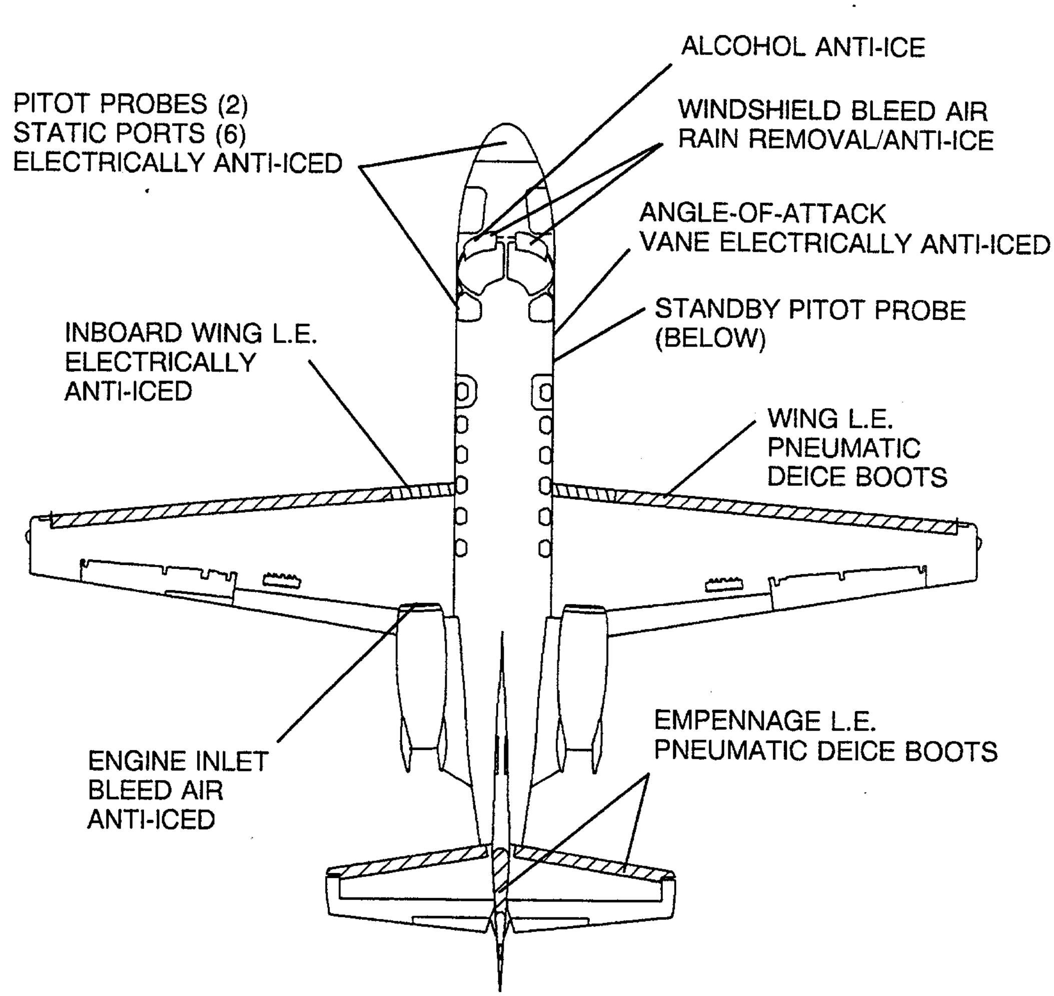

Figure 2-21

The deice system provides a means of removing ice which has formed on the wing leading edge (outboard of the electrically heated portion of the wings in front of the engines), and on the aerodynamic surfaces of the empennage. The system operates by expanding and contracting pneumatically operated boots.

(Continued Next Page)

PILOT'S SWITCH PANEL WITH ANTI-ICE AND DEICE SYSTEM CONTROLS

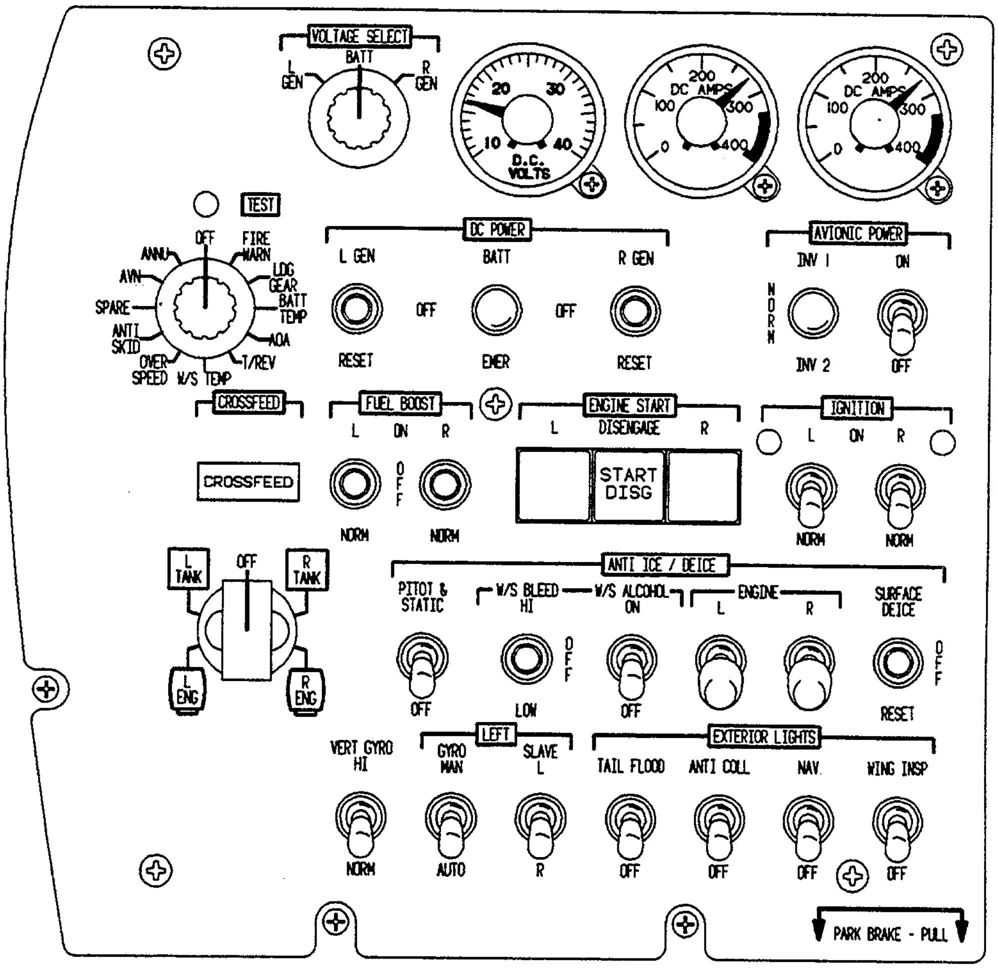

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Figure 2-22

ANTI-ICE/DEICE SYSTEMS (Continued)

NOTE

- Icing conditions exist when the ambient temperature on the ground and for takeoff is +10°C or lower; the indicated RAT inflight is +10°C or lower; and visible moisture in any form is present (i.e. clouds, fog with visibility of one mile or less, rain, snow, sleet or ice crystals).
- Icing conditions also exist when the ambient temperature on the ground and for takeoff is +10°C or lower when operating on ramps, taxiways or runways where snow, ice, standing water, or slush may be ingested by the engines or freeze on engine nacelles or engine sensor probes.

ENGINE ANTI-ICE SYSTEM

The engine anti-ice systems consist of bleed air heated engine inlet leading edges and electrical anti-ice protection of the inboard wing leading edges in front of the engines. The engine is anti-iced by directing hot bleed air through the inner fan exit stators through electrically controller "energize-to-close" solenoid valves in each engine bleed air system. Approximately 60% N_2 RPM is required to open these valves and to maintain them in the open position. Hot engine bleed air also flows constantly through the engine fan nose cone and around the inlet temperature probe, independently of the engine anti-ice system. Selecting engine anti-ice also initiates continuous ignition.

The engine anti-ice is controlled by switches (L/OFF and R/OFF) on the pilot's switch panel. Activation of either engine anti-ice system also activates the corresponding inboard wing leading edge electrical anti-ice. The inboard wing anti-ice is separate from the pneumatic boot system of the outboard wings and the horizontal stabilizer and vertical stabilizer, which are controlled by the SURFACE DEICE OFF/RESET switch. The electrical inboard leading edge consists of a 61-inch section of electrically heated panel. Operation of the inboard leading edge and auto-ignition is dependent only on a source of electrical power and not on engine RPM.

Each inboard wing section incorporates five heating elements and a thermal control switch. With engine anti-ice selected, each side will draw approximately 150 amps of electrical power. The control switch causes the elements to cycle off and on to maintain a temperature between 54°C and 78°C.

Cockpit indications of system function are obtained from the RPM, ITT and AMPS gages and the amber L and R ENG ANTI-ICE annunciator panel lights. Opening of the stator and inlet cowl valves will be shown by an ITT rise and RPM decrease, indicating bleed air extraction is taking place. Electrical power to the inboard wing leading edges will cause an increase in generator load on the ammeters.

With the respective switch on, an ENG ANTI-ICE light will illuminate for any one of the following conditions:

1. Either the cowl or stator valve fails to open. (A five-second delay is normal from the time the switch is turned on until the valves move.)
2. Cowl leading edge temperature below 104°C.
3. Inboard wing section below 16°C.
4. Failure of one or more wing heating elements (if the system is cycling with a failed heater, the L or R ENG ANTI-ICE light will illuminate each time the system cycles on).
5. Failure of the temperature controller. (If the system is cycling with a failed controller, the L or R ENG ANTI-ICE light will illuminate each time the system cycles off.)

(Continued Next Page)

ENGINE ANTI-ICE SYSTEM (Continued)

Upon initiating system operation, the L and R ENG ANTI-ICE annunciators will illuminate, indicating operating temperature has not been achieved. The time for the lights to extinguish after initiating operation will vary with outside air temperature and engine power setting. Normally, no more than two minutes are required at cruise or climb thrust settings. During descent into anticipated icing conditions, due to the normally associated low power settings it is advisable to turn on the system well before entering the visible moisture environment. Once the conditions necessary to extinguish the lights are satisfied, a minimum power setting of approximately 60% turbine (N_2) RPM will sustain operation.

Engine anti-ice is, as the name implies, designed as a preventive system. Its use should be anticipated and the system actuated any time flight in visible moisture with an indicated OAT of from +10°C to -30°C is imminent. Failure to turn on the system before ice accumulation has begun may result in engine damage due to ice ingestion. For sustained ground operation in visible moisture at from +10°C to -30°C, the system should be turned on one minute out of four with N_2 set above 65%.

Because of engine bleed air extraction with system operation, maximum allowable power settings are reduced as shown in Section IV of the FAA Approved Flight Manual.

Loss of electrical power to the engine anti-ice valves will cause them to fail to the open position, ensuring anti-ice capability. This fact must be considered when setting engine power if a complete electrical failure, or failure of electrical power to the engine anti-ice system, should be experienced.

SURFACE DEICE SYSTEM

The surface deice system consists of pneumatic boots on the leading edges of both wings, the vertical tail, and the horizontal stabilizer, three control valves, a pressure regulator, wing and horizontal stabilizer pressure switches, a system timer, a control switch and a SURFACE DEICE annunciator. The white SURFACE DEICE annunciator will illuminate any time the wing and/or horizontal stabilizer deice pressure switches sense a minimum of 21 PSI in the corresponding pneumatic system. The system is protected by a five-ampere circuit breaker marked SURFACE DEICE on the left circuit breaker panel.

The airframe deice boots are controlled by a three-position SURFACE DEICE switch which is spring-loaded to OFF. It provides two six-second cycles following momentary actuation. Boot cycling is controlled by three control valves. On the first six-second cycle, one valve opens to inflate the boots on the empennage. Two control valves actuate on the second cycle to direct air to both wings. The time circuit will elapse twelve seconds after initiation and deenergize the control valves. The boots deflate by bleeding the air back through the control valve and dumping it overboard. The boots are held deflated by vacuum.

(Continued Next Page)

SURFACE DEICE SYSTEM (Continued)

In the event the boots remain inflated or it is desirable to stop boot inflation and terminate the cycle, place the surface deice switch to the RESET position. This overrides the timer circuit and immediately deactivates the control valves. It is not necessary to go to the reset position after every boot cycle. Returning the switch to the OFF position prepares the system for the next actuation. Satisfactory operation of the deice boot cycle is verified by illumination of the surface deice annunciator light and visual inspection of the wing leading edges. Illumination of the SURFACE DEICE light indicates there is bleed air pressure to the boots for inflation. The light will blink off momentarily between each cycle. Operation of the boots should be functionally checked prior to icing encounters while on the ground or in flight with the OAT at or above -40°C (-40°F).

NOTE

When the horizontal stabilizer de-ice boots are inflated with the autopilot disengaged, there is a tendency for the airplane to pitch nose up.

Surface deice should be used when ice buildup is estimated between 1/4 and 1/2 inch thickness. Early activation of the boots may result in ice bridging on the wing. If accumulation is in excess of 1/2 inch, boot cycling may not clear it. A wing inspection light is provided to illuminate the left wing to observe ice buildup during night flight.

During icing encounters, the crew should monitor the wing for any evidence of a failed deice boot. During normal operation, some ice may form on unprotected areas.

CAUTION

IN ICING CONDITIONS, A SMALL AMOUNT OF RESIDUAL ICE WILL FORM ON UNPROTECTED AREAS. THIS IS NORMAL, BUT CAN CAUSE AN INCREASE IN STALL SPEEDS. WHEN ANY AMOUNT OF RESIDUAL ICE IS VISIBLE, THE STALL SPEEDS IN FIGURE 4-8 INCREASE BY 4 KNOTS; THE V_{REF}/V_{APP} SPEEDS, LANDING DISTANCES AND THE MAXIMUM LANDING WEIGHT PERMITTED BY CLIMB REQUIREMENTS OR BRAKE ENERGY LIMITS MUST BE ADJUSTED IN ACCORDANCE WITH FIGURE 4-36.

The deice boots should not be operated when indicated outside air temperature (IOAT or RAT) is below -40°C (-40°F) since cracking of the boots may occur below that temperature and the boots may not fully deflate.

PITOT-STATIC AND ANGLE-OF-ATTACK ANTI-ICE

Electric elements heat the pilot's and copilot's pitot tubes, the standby pitot tube, the static ports, and the angle-of-attack vane. The PITOT & STATIC anti-ice switch on the lower left panel controls power to these elements. Amber annunciator lights (P/S HEATER, L or R) will come on when power is removed from the pilot and/or copilot heaters or when a heater fails. The angle-of-attack vane heater (AOA HTR) and the standby pitot-static system heaters (STBY P/S HTR) are separately annunciated by amber lights to warn of their failure, or lack of power. Ground operation of the pitot-static heat should be limited to less than two minutes to avoid damage to the pitot-static system and the angle-of-attack vane heater.

SURFACE DEICE SYSTEM

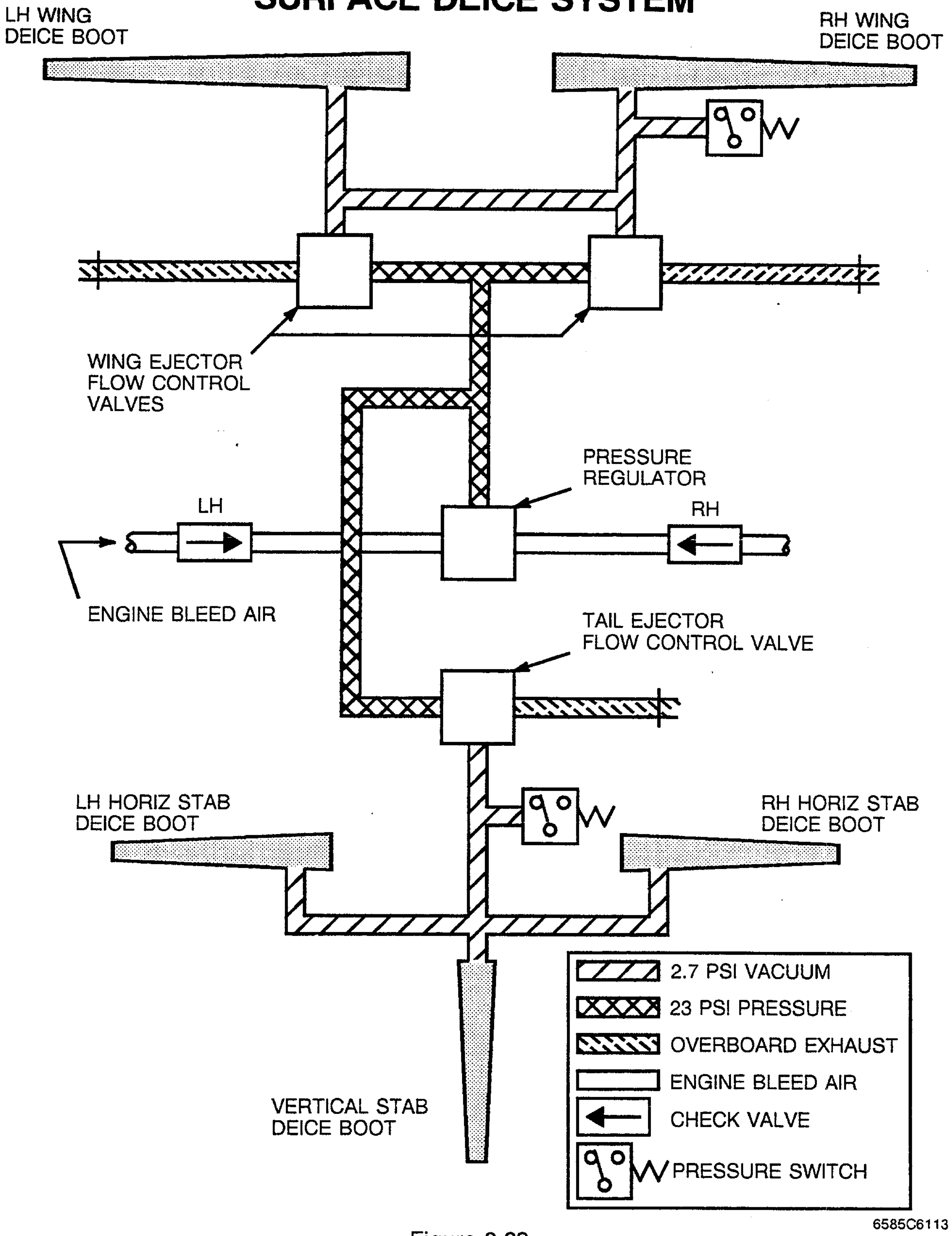

Figure 2-23

WINDSHIELD ANTI-ICE

The windshield bleed air system provides windshield anti-ice under all normal operating conditions. This system also provides external windshield defog and rain removal. The system supplies engine bleed air through an electrically actuated pressure regulating shutoff valve located in the tailcone of the airplane, and manually positioned valves which regulate air to each windshield. The manual valves are located at each windshield bleed air nozzle and are left in the OFF position for normal operation. A check should be made to ensure that the rain removal knob is pushed IN, prior to turning the windshield bleed switch on. When windshield anti-icing is required, the W/S bleed valves are turned ON and the W/S bleed switch is turned to LOW if the indicated outside air temperature (OAT) is above -18°C or to HI if the indicated OAT is -18°C or below. Normal system operation is indicated by an increase in air noise as the bleed air discharges from the nozzles. Temperature sensors, located near the discharge nozzles and in the tailcone, provide inputs to a controller to automatically control the windshield bleed air to 138°C, plus or minus 5°C (HI), or 127°C, plus or minus 5°C (LOW), by modulating crossflow air through a heat exchanger in the tailcone. An additional temperature sensor, located in the windshield bleed air line, automatically actuates the electrical shutoff valve and illuminates the windshield air overheat annunciator light (WS AIR O'HEAT) should the bleed air temperature exceed 146°C. This condition should not occur unless a sustained high power, low airspeed condition is maintained or a system malfunction occurs.

In the event of a complete electrical system failure, the bleed air control valve would open and the overheat annunciator would be inoperative. If the manual bleed air valves are open, they should be closed as soon as practical, subject to icing conditions. Damage to the windshield could result from continued operation without electrical control.

Self-test of the temperature monitor system is normally accomplished during the preflight warning systems check by selecting the W/S TEMP position on the rotary test switch and turning the windshield bleed air switch to either the HI or LOW position. Proper system function is verified by illumination of the windshield air overheat annunciator light. Self-tests may also be accomplished in flight, if desired.

If the windshield bleed air anti-ice system fails, a backup alcohol anti-ice system is provided for the left windshield only. The system is controlled by a two-position W/S ALCOHOL switch which, when moved to the ON position, activates an electric pump which sprays alcohol on the pilot's windshield. Sufficient alcohol is provided for approximately ten minutes continuous operation with a fully serviced reservoir.

RAIN REMOVAL

This system utilizes the normal windshield bleed air anti-ice system for rain removal with augmenter doors to provide increased airflow over each windshield in heavy rain. These doors are manually operated by pulling the PULL RAIN handle located under the WINDSHIELD BLEED AIR knobs on the copilot's subpanel. For rain removal, the manual windshield bleed air controls on the copilot's subpanel should be turned to the MAX position, the PULL RAIN handle pulled out and the W/S BLEED switch positioned to LOW. Augmenter door opening will be difficult should the W/S BLEED switch be turned on first. It may also be difficult to open above 175 KIAS.