NAL/PUR/CAD/373/20-Z[G] 15-Feb-2022

PROCEEDINGS OF THE PRE-BID CONFERENCE THROUGH WEBEX TOWARDS DESIGN, DEVELOPMENT AND SUPPLY OF PNEUMATIC DEICING SYSTEM.

The Pre-bid Conference was held and the following T&PC members attended the meeting: -

Sl. No.	Name & Designation		Role
1	Dr. M. Manjuprasad	Chief Scientist, STTD	Chairman
2	Mr. J. Ramaswamy Setty	Sr. Principal Scientist, ACD	Member
3	Mr. Dilip Kumar Sahu,	Sr. Technical Officer-2, CAD	Member
4	Mr. Vineet Kumar	Chief Scientist, RNCAC	PD-SARAS Member
5	Dr. Abhay Pashilkar	Chief Scientist, FMCD	Prog- Director Member
6	Mr. C. A. Vinay	Principal Scientist, RNCAC	Specialist Member
7	Mr. Bhaskar Chakravarthy	Chief Scientist, RNCAC	Specialist Member
8	Mr. Lakshminarayana	Chief Scientist, RNCAC	Invitee
9	Mr. Malisetty Leela Shankar	Principal Scientist, RNCAC	Member - Convener (TSC)

The list of Prospective bidders who attended the Pre-bid Conference is as per **Annexure-I.**

At the outset, the Chairman welcomed all the Members and the representatives of the Bidders and briefed in general the scope of the Project. The Indenting Officer to read out the clarification sought by the bidders and the replied thereto as detailed in **Annexure-II (Part A: Technical Clarification and Part B: Commercial Clarification, if any).**

The representatives present were satisfied with the replies given and it was informed that the corrections / additions / clarifications given, as discussed during the Pre-Bid Conference would be hosted on the website of CSIR-NAL and all prospective bidders are required to take cognizance of the proceedings of the Pre-Bid Conference before formulating and submitting their bids as stipulated in bidding Documents.

The meeting ended with a vote of thanks to the Chair.

Encl: as above.

J. Ramaswamy Setty
Member

Dilip Kumar Sahu
Member

Vineet Kumar
Member

Dr. Abhay Pashilkar
Member

C. A. Vinay
Specialist Member

Bhaskar Chakravarthy
Specialist Member

Lakshminarayana
Invitee

Malisetty Leela Shankar
Member – Convener (TSC)

Dr. M. Manjuprasad
Chairman-T&PC

CSIR-NATIONAL AEROSPACE LABORATORIES
BENGALURU - 560 017

TENDER NO.: NAL/PUR/CAD/373/20-Z

ANNEXURE - I

DATE & TIME : 15-Feb-2022 @ 02:00 PM

VENUE: ICAST, Conference Hall, 2nd Floor, Kodihalli, CSIR-NAL and THROUGH WEBEX

Pre-Bid Conference for Design, Development and Supply of Pneumatic Deicing System

ATTENDANCE SHEET - T&PC MEMBERS

Sr. No.	Name		Signature
1	Dr. M. Manjuprasad, Chief Scientist, STTD	Chairman	
2	Mr. J. Ramaswamy Setty, Sr. Principal Scientist, ACD	Member	
3	Mr. Dilip Kumar Sahu,Sr.Technical Officer-2, CAD	Member	
4	Dr. Abhay Pashilkar, Chief Scientist, FMCD	PGD-CAP, Member	
5	Mr. Vineet Kumar, Chief Scientist, RNCAC	PD, Member	
6	Mr. C.A Vinay, Principal Scientist, RNCAC	Specialist-Member	
7	Mr. Bhaskar Chakravarthy, Chief Scientist, RNCAC	Specialist-Member	
8	Mr. Lakshminarayana, Chief Scientist, RNCAC	Invitee	
9	Mr. Malisetty Leela Shankar, Principal Scientist, RNCAC	Member- Convenor - TSC	

NATIONAL AEROSPACE LABORATORIES
BENGALURU - 560 017

TENDER NO. NAL/PUR/CAD/373/20-Z

ANNEXURE - I

DATE & TIME : 15-Feb-2022 @ 11:00 AM

VENUE: THROUGH WEBEX

Pre-Bid Conference for Design, Development and Supply of Pneumatic Deicing System

ATTENDANCE SHEET - PROSPECTIVE BIDDERS

Sr. No.	Name of the Firm	Name & Designation of Representative	E-tender Registration (Yes/No)	Email ID	Signature
1	M/s Collins Aerospace	Mr Yugandhar Metta, Senior Manager - Business Development | Military Avionics & Helicopters COLLINS AEROSPACE , Bangaolore	NO	Yugandhar.Metta@collins.com	Webex participation
2	M/s Collins Aerospace	Mr Shashikiran Ananth, Technical Team,COLLINS AEROSPACE , Bangaolore	NO		Webex participation
3	M/s Collins Aerospace	Mrs Sudha Damodaran,Technical Team,COLLINS AEROSPACE , Bangaolore	NO	Sudha.Damodaran@collins.com	Webex participation
4	M/s Collins Aerospace	Mr Rhushikesh Patil,Technical Team,COLLINS AEROSPACE , Bangaolore	NO	Rhushikesh.Patil@collins.com	Webex participation
5	M/s Collins Aerospace	Mr Shyam Kumar Dattatri,Technical Team,COLLINS AEROSPACE , Bangaolore	NO		Webex participation
6	M/s Collins Aerospace	Mr Samvit Katti Gopal,Technical Team,COLLINS AEROSPACE , Bangaolore	NO		Webex participation
7	M/s Collins Aerospace	Mr Sugumaran Selvaraj,Technical Team,COLLINS AEROSPACE , Bangaolore	NO		Webex participation
8	M/s Collins Aerospace	Mr Priyank Anavadiya,Technical Team,COLLINS AEROSPACE , Bangaolore	NO		Webex participation
9	M/s Collins Aerospace	Mr Scott,COLLINS AEROSPACE	No	Scott.Indermuhle@collins.com	Could not join

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(This chapter 4 (amended) supersedes the chapter 4 provided in tender document no: NAL/PUR/CAD/373/20-Z(G) dated 27th January 2022)

Chapter 4

Specifications and Allied Technical Details for Pneumatic Deice System

Part A	Pneumatic Deice system – Leading Edges of Wing, VT and HT
Part B	Pneumatic Deice system – Leading Edges of Wing, VT, HT and Engine Air intake Lip

4.1 End Use: SARAS Mk II Aircraft

4.2 Detailed Specifications

4.2.1 PART-A: Specification of Pneumatic Deice system – Leading Edges of Wing, VT and HT

Pneumatic Deice system should meet FAR-23 amendment 23-64 performance-based regulations. The prescriptive provisions within previous amendment 63 of FAR-23, where applicable, may be used at aircraft ambient air temperatures from -55 °C to +70 °C.

Qualification tests of the system components/LRUs to conform to RTCA DO-160D or above upto RTCA DO-160G / Equivalent

1.	**Areas for Deicing (values given are approximate and are as suggestions only. Supplier to confirm against calculations or analysis)**	
a)	Wing leading edge (L.H. and R.H.) (Typical)	LH-0.52 m^2 (IB), 0.89 m^2 (C), 0.94 m^2 (OB), RH-0.52 m^2 (IB), 0.89 m^2 (C), 0.94 m^2 (OB)
b)	Horizontal stabilizer leading edge (L.H. and R.H.) (Typical)	LH:0.84 m^2; RH:0.84 m^2
c)	Vertical stabilizer leading edge (Typical)	0.44 m^2
2.	**Engine bleed air supply to the deice system**	
a)	Temperature range	min 40 deg C & max 100 deg C
b)	Pressure range	32 ± 3 psig
c)	Maximum permissible instantaneous mass flow rate demand	4 lb/min (operational mode of de-ice system) 1 lb/min (non-operational mode of de-ice system, for continuous vacuum suction of boots)
3.	**Inflatable rubber boot specification (Typical and given as suggestions only)**	
a)	Material	Fabric reinforce rubber sheet containing inflatable tubes
b)	Width of tube	25 mm
c)	Max. thickness	2.5 mm
d)	Weight	Not more than 2.25 kg per sq. m (total weight with this specification is ~18kg)
e)	Max. pressure	21 psig
f)	Temperature range (survival)	-55° C to +100° C
g)	Vacuum	2 to 5 psig to maintain the de-ice tube tubes in a flat or deflated condition
h)	Electrical	Deice: maximum 6.3 amps @ 28 V DC

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i)	(i)	Mechanical equipment for regulating the deicer operating bleed air coming from Bleed system of Precooler heat exchanger.
	(ii)	Electro-Mechanical equipment to control the deice system.
	(iii)	Deice system should have I-BIT feature. System Controller should indicate built in failure of components (For example: Timer, Ejector Flow Control Valves etc.) in the form of ARINC 429 or Discreate.
	(iv)	Ice detection system supplied as a part of pneumatic Deice system shall detect ice formation accurately
	(v)	The Deice system shall accept all the signals from the control panel in their native form.
	(vi)	All signal outputs from Deice system (its components and sensors) shall be compatible to ARINC 429 communication protocol.
	(vii)	Two ARINC 429 output channels shall be provided, for redundant purpose.
	(viii)	Other required components for the functioning of Deice System shall be included.
	(ix)	Individual Component Dimensional Drawings with weight shall be provided.
	(x)	The proposed system shall be based on components/LRUs as far as possible off the shelf brand new with long lead service life and on condition maintenance.
j)	Proof Pressure: 1.5 times of System Design Pressure Burst Pressure: 3 times of System Design Pressure	

Note: The wing, H.T. and V.T are made of composite materials.

4.2.2 Full Qualification Tests.

i. Off The shelf- LRUs documents supporting means of compliance of qualification tests as per RTCA DO-160D or above upto RTCA DO-160G / Equivalent, means of compliance of Acceptance & Performance Tests, Endurance Test documents supporting means of compliance to meet the useful life of 30 years or 30000 flying hours have to be submitted to CSIR-NAL.

(Request bidder to provide means of compliance of qualification tests details, Acceptance & Performance Tests and Endurance Test as part of bid submission).

ii. LRUs to be designed and developed to meet CSIR-NAL Pneumatic Deice system specifications & requirements, qualification schedules as per RTCA DO-160D or above upto RTCA DO-160G / Equivalent, Acceptance & Performance Tests schedules have to be submitted to CSIR-NAL.
Endurance Test and its pass/fail criteria has to be proposed by bidder as per Pneumatic Deice system bidder's standard practices to meet the useful life of 30 years or 30000 flying hours and endurance test schedules have to be submitted to CSIR-NAL.

(Request OEM/Vendor to provide means of compliance of qualification tests plan details, Acceptance & Performance Tests plan details and Endurance Test plan details as part of bid submission)

The following tests shall be performed on the Pneumatic Deice system LRUs as part of Full Qualification Test.

a) Acceptance & Performance Tests
   - Initial Visual Examination and Measurement of Weight and Physical Parameters
   - Performance/Functional

   Checks
   - Thermal Shock
   - Thermal Performance and Pressure Drop
   - Endurance Test

b) Environmental Tests (Qualification tests as per RTCA DO-160D or above upto RTCA DO-160G / Equivalent)

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Table1: Environmental Qualification Map of Pneumatic Deice System Items/LRUs as per RTCA DO-160D or above up to RTCA Do-160G

Requirements	RTCA DO-160	Item - Ice Detector	Items - With Electrical Interface	Items - Without Electrical Interface
Location		Nose Cone (Uncontrolled Pressure and uncontrolled Temperature)	Centre wing Forward Faring (Uncontrolled Pressure and uncontrolled Temperature)	Centre wing Forward Faring (Uncontrolled Pressure and uncontrolled Temperature)
Temperature and Altitude	Section 4	Category C4: Operating Low Temp (OLT): Soak at -40 deg C for 3 hours minimum and operate at -40 degC for 30 minutes; Operating High Temp (OHT): +55 degC; Altitude: 30000 feet.	Category C4: Operating Low Temp (OLT): Soak at -40 deg C for 3 hours minimum and operate at -40 degC for 30 minutes; Operating High Temp (OHT): +55 degC; Altitude: 30000 feet.	Category C4: Operating Low Temp (OLT): Soak at -40 deg C for 3 hours minimum and operate at -40 degC for 30 minutes; Operating High Temp (OHT): +55 degC; Altitude: 30000 feet.
Temperature Variation	Section 5	Category B : Rate of change of Temperature: 5 degC per minute: Operating Low Temp (OLT): -40 degC; Operating High Temp (OHT): +55 degC.	Category B: Rate of change of Temperature: 5 degC per minute; Operating Low Temp (OLT): -40 degC; Operating High Temp (OHT): +55 degC.	Category B: Rate of change of Temperature: 5 degC per minute: Operating Low Temp (OLT): -40 degC; Operating High Temp (OHT): +55 degC.
Humidity	Section 6	Category C: Temperature: 38±2 to 65±2 (deg C); Humidity: 85±4 to 95±4 (% RH); Number of Cycles: 6 Days (144 Hours of exposure)	Category B: Temperature: 38±2 to 65±2 (deg C); Humidity: 85±4 to 95±4 (% RH); Number of Cycles: 10 Days (240 Hours of exposure).	Category B: Temperature: 38±2 to 65±2 (deg C); Humidity: 85±4 to 95±4 (% RH); Number of Cycles: 10 Days (240 Hours of exposure).
Operating Shock and Crash Safety	Section 7	Category B: OS: 6g for 11 ms; CS: 20g for 11ms; Crash Safety Sustained (Structural linear acceleration): 9g in all direction for Random orientation.	Category B: OS: 6g for 11 ms; CS: 20g for 11ms; Crash Safety Sustained (Structural linear acceleration): 9g in all direction for Random orientation.	Category B: OS: 6g for 11 ms; CS: 20g for 11ms; Crash Safety Sustained (Structural linear acceleration): 9g in all direction for Random orientation.
Vibration Endurance	Section 8	Cat. S, Test Curve M	Cat. S, Test Curve L: Standard Sinusoidal Vibration Test is DESIRABLE; Dwell time of 15 minutes is DESIRABLE at each severe frequency selected from the critical frequencies.	Cat. S, Test Curve L: Standard Sinusoidal Vibration Test is DESIRABLE; Dwell time of 15 minutes is DESIRABLE at each severe frequency selected from the critical frequencies.
Explosive Proofing	Section 9	Category H, Category Zone III: Component shall be tested for the thermal ignition in the operating range +65 to +260 degC.	Category H, Category Zone III: Component shall be tested for the thermal ignition in the operating range +65 to +260 degC.	Category H, Category Zone III: Component shall be tested for the thermal ignition in the operating range +65 to +260 degC.
Water-proofing	Section 10	Category Y: Equipment OFF: Low Temp: -10 degC & 85% RH, stabilize for 3 hours. Operating: at High Temp: +40 degC & 85% RH, operate for 10 minutes	Category Y: Equipment OFF: Low Temp: -10 degC & 85% RH, stabilize for 3 hours. Operating: at High Temp: +40 degC & 85% RH, operate for 10 minutes	Category Y: Equipment OFF: Low Temp: -10 degC & 85% RH, stabilize for 3 hours. Operating: at High Temp: +40 degC & 85% RH, operate for 10 minutes
Fluids Susceptibility	Section 11	Category F: Spray test: Wetting for 8 hours followed by a drying period of 16 hours at 65 degC, Number of cycles: Three 24-four hours cycles	Category F: Spray test: Wetting for 8 hours followed by a drying period of 16 hours at 65 degC, Number of cycles: Three 24-four hours cycles	Category F: Spray test: Wetting for 8 hours followed by a drying period of 16 hours at 65 degC. Number of cycles: Three 24-four hours cycles
Sand and Dust	Section 12	Category D Dust test: 3.5 to 8.8g/m3 and 97 to 99% silicon dioxide, air velocity is 0.5 to 2.4 m/s;	Category D Dust test: 3.5 to 8.8g/m3 and 97 to 99% silicon dioxide, air velocity is 0.5 to 2.4 m/s;	Category D Dust test: 3.5 to 8.8g/m3 and 97 to 99% silicon dioxide, air velocity is 0.5 to 2.4 m/s.
Fungus Resistance	Section 13	Category F: Incubation at +30 degC and 97±2% RH, for 28 days after satisfactory fungus growth.	Category F: Incubation at +30 degC and 97±2% RH, for 28 days after satisfactory fungus growth.	Category F: Incubation at +30 degC and 97±2% RH, for 28 days after satisfactory fungus growth.
Salt Spray	Section 14	Category S: 24 hours' exposure to salt fog and 24 hours dry at ambient with 50%RH; Number of cycles: 2	Category S 24 hours' exposure to salt fog and 24 hours dry at ambient with 50%RH; Number of cycles: 2	Category S: 24 hours' exposure to salt fog and 24 hours dry at ambient with 50%RH; Number of cycles: 2
Magnetic Effect	Section 15	Category A :0.3m < D ≤ 1m	Category C : D > 3.0m	Category C: D > 3.0m
Power Input	Section 16	Category B: Normal Operating Tests: 30.3 V, 22.0 V & 18.0 V; Momentary Power Interruption Test: Interruption 50 ms;	Category B: Normal Operating Tests: 30.3 V, 22.0 V & 18.0 V; Momentary Power Interruption Test: Interruption 50 ms;	Category B: Normal Operating Tests: 30.3 V, 22.0 V & 18.0 V; Momentary Power Interruption Test: Interruption 50 ms;
Voltage Spike	Section 17	Category A: Minimum of 50 positive polarity transients within a period of one minute: Repeat the application with 50 negative polarity transients within a one-minute period.	Category A: Minimum of 50 positive polarity transients within a period of one minute; Repeat the application with 50 negative polarity transients within a one-minute period.	Category A: Minimum of 50 positive polarity transients within a period of one minute: Repeat the application with 50 negative polarity transients within a one-minute period.
Audio Frequency Conducted Susceptibility - Power Input	Section 18	Category B	Category B	NA
Induced Signal Susceptibility	Section 19	Category ZCE: Magnetic Fields Induced into the Equipment: 20 A rms at 400 Hz; Magnetic Fields Induced into Interconnecting Cables: IxL=30 A-m at 400Hz reducing to 0.8 A-m at 15kHz Electric Fields Induced into Interconnecting Cables: VxL=1800 V-m from 380 to 420Hz; Spikes Induced into Interconnecting Cables: Cable length: 3m/ 3m/ 1.2m Amplitude 600V p-p Duration: 50- 1000µs Repetition rate 0.2 to 10µs.	Category ZCE: Magnetic Fields Induced into the Equipment: 20 A rms at 400 Hz; Magnetic Fields Induced into Interconnecting Cables: IxL=30 A-m at 400Hz reducing to 0.8 A-m at 15kHz Electric Fields Induced into Interconnecting Cables: VxL=1800 V-m from 380 to 420Hz; Spikes Induced into Interconnecting Cables: Cable length: 3m/ 3m/ 1.2m Amplitude 600V p-p Duration: 50- 1000µs Repetition rate 0.2 to 10µs.	Category ZCE: Magnetic Fields Induced into the Equipment: 20 A rms at 400 Hz; Magnetic Fields Induced into Interconnecting Cables: IxL=30 A-m at 400Hz reducing to 0.8 A-m at 15kHz Electric Fields induced into Interconnecting Cables: VxL=1800 V-m from 380 to 420Hz; Spikes induced into Interconnecting Cables: Cable length: 3m/ 3m/ 1.2m Amplitude 600V p-p Duration: 50- 1000µs Repetition rate 0.2 to 10µs.
Radio Frequency Susceptibility (Radiated and Conducted)	Section 20	Category RR: Conducted Susceptibility: Conducted: 30 mA; Radiated Susceptibility: Electric Field: 100 V/m.	Category RR: Conducted Susceptibility: Conducted: 30 mA; Radiated Susceptibility: Electric Field: 100 V/m.	Category RR: Conducted Susceptibility: Conducted: 30 mA; Radiated Susceptibility: Electric Field: 100 V/m.
Emission of Radio Frequency Energy	Section 21	Category L: Conducted RF Emissions: 150 KHz to 152 MHz.; Radiated RF Emission Category L 100 MHz to 6000 MHz	Category H: Conducted RF Emissions: 150 KHz to 152 MHz; Radiated RF Emission: 100 MHz to 6000 MHz.	NA
Lightning Induced Transient Susceptibility	Section 22	A3XX as per DO-160D OR A3E3L3 or A3XXXX as per DO-160G	A3XX as per DO-160D OR A3E3L3 or A3XXXX as per DO-160G	NA
Lightning Direct Effects	Section 23	Category ZZ1A	Category ZZ2A	NA
Icing	Section 24	Category C: Uniform water spray for 1 hour.	NA	NA
Electrostatic Discharge Requirements	Section 25	Category A: ESD pulses at a test level of 15000 volts	Category A: ESD pulses at a test level of 15000 volts	NA
Fire, Flammability	Section 26	Category C: Testing is not necessary	Category C: Testing is not necessary	NA

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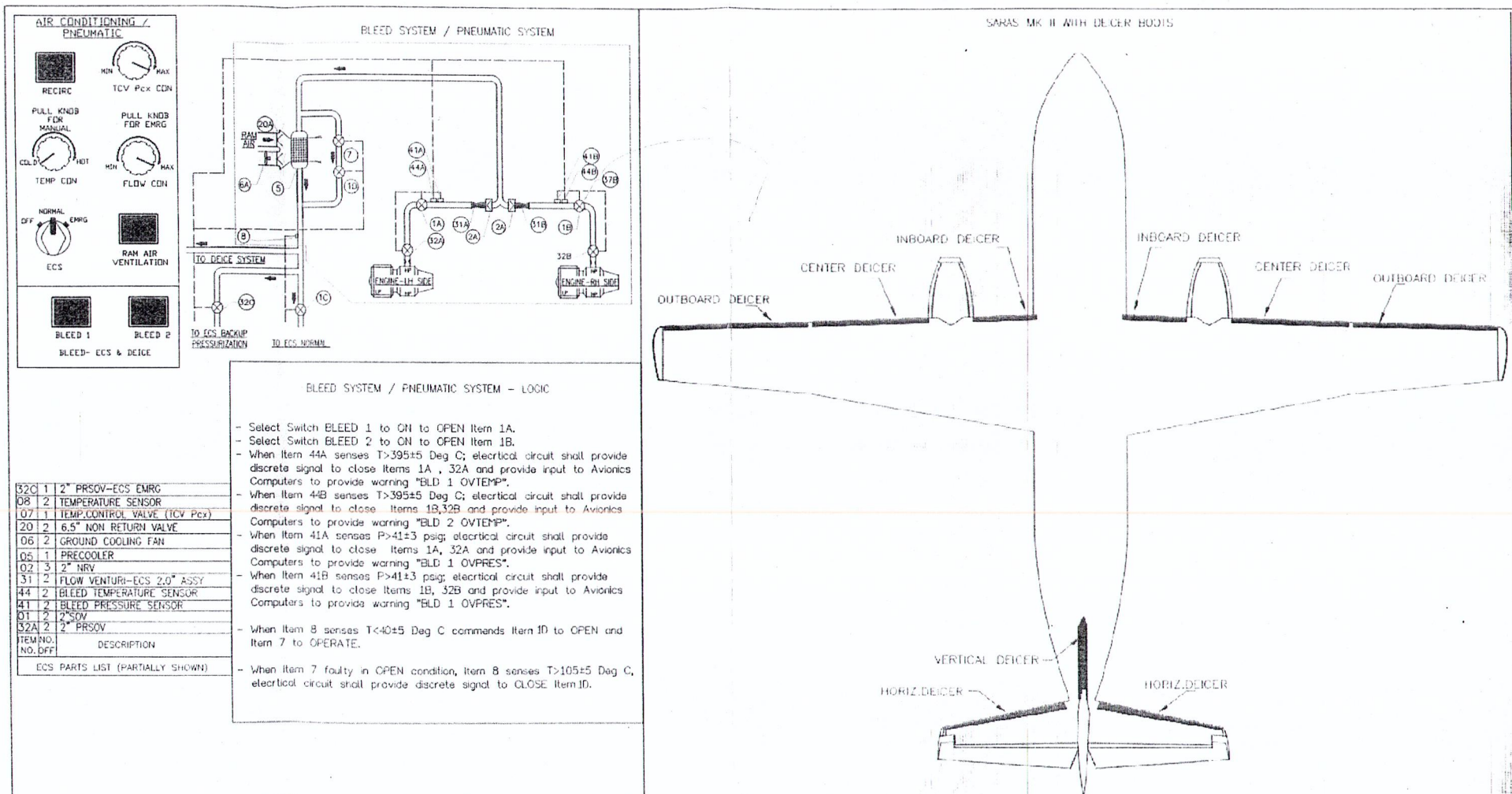
4.2.3 Pneumatic Deice System of Saras Mk II with Pneumatic Deicers - Leading Edges of Wing, VT and HT

Figure 1 shows Saras Mk II Aircraft with Pneumatic Deicers. Bleed System/Pneumatic System is shown for reference. The Bidder shall propose suitable architecture based on off-the-shelf items as far as possible to meet the requirements of System specifications and safety, Reliability requirements as per FAR 23.1309 amendment 23-64. Ice detectors location shall be identified by the Bidder.



ITEM NO.	NO. OFF	DESCRIPTION
32C	1	2" PRSOV-ECS EMRG
08	2	TEMPERATURE SENSOR
07	1	TEMP.CONTROL VALVE (TCV Pcx)
20	2	6.5" NON RETURN VALVE
06	2	GROUND COOLING FAN
05	1	PRECOOLER
02	3	2" NRV
31	2	FLOW VENTURI-ECS 2.0" ASSY
44	2	BLEED TEMPERATURE SENSOR
41	2	BLEED PRESSURE SENSOR
01	2	2"SOV
32A	2	2" PRSOV

ECS PARTS LIST (PARTIALLY SHOWN)

BLEED SYSTEM / PNEUMATIC SYSTEM - LOGIC

- Select Switch BLEED 1 to ON to OPEN Item 1A.
- Select Switch BLEED 2 to ON to OPEN Item 1B.
- When Item 44A senses T>395±5 Deg C; electrical circuit shall provide discrete signal to close Items 1A , 32A and provide input to Avionics Computers to provide warning "BLD 1 OVTEMP".
- When Item 44B senses T>395±5 Deg C; electrical circuit shall provide discrete signal to close Items 1B,32B and provide input to Avionics Computers to provide warning "BLD 2 OVTEMP".
- When Item 41A senses P>41±3 psig; electrical circuit shall provide discrete signal to close Items 1A, 32A and provide input to Avionics Computers to provide warning "BLD 1 OVPRES".
- When Item 41B senses P>41±3 psig; electrical circuit shall provide discrete signal to close Items 1B, 32B and provide input to Avionics Computers to provide warning "BLD 1 OVPRES".
- When Item 8 senses T<40±5 Deg C commands Item 10 to OPEN and Item 7 to OPERATE.
- When Item 7 faulty in OPEN condition, Item 8 senses T>105±5 Deg C, electrical circuit shall provide discrete signal to CLOSE Item 10.

Figure 1: Saras Mk II Aircraft with Pneumatic Deicers - Leading Edges of Wing, VT and HT

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4.2.3.1 Bleed System:

Bleed air is supplied to Pneumatic Deice System. Bleed Air System operated after Engines start at and above Flight Idle (FI) onwards only. The Bleed air system has control valves near Engine 1 and 2 and NRVs near T-joint of Bleed line from Engine 1 and 2. The Bleed air system has Venturi meter with flow sensor. Because of the limit imposed by engine group the system should ensure that at no flight condition more than 22 lb/min bleed flow shall not be drawn from engines. There is a common Precooler heat exchanger for ECS Normal System, Emergency Backup Pressurization System and Deice System. Precooler is cooled by coolant air supplied by ground cooling fan on ground and by ram air in flight. The bleed system shall have TCV driven by pass logic to ensure the Precooler outlet temperature after bypassing shall be in the range of 40 to 100 deg C, to meet the requirements of the pneumatic deice system.

4.2.4 Requirements of Pneumatic Deice System - Leading Edges of Wing, VT and HT

a) The icing impingement analysis (FAA Part 23, Section 23.1419) shall be performed on the Wing, Vertical Tail (VT) and Horizontal Tail (HT) of the NAL SARAS Mk II aircraft. The analysis shall be performed using appropriate (industry standard) Ice Accretion Code. The purpose of the analysis is to define the extents of icing impingement in order to estimate the pneumatic deicer coverage required to provide adequate ice protection. Flight conditions and airfoil data to be used in the analysis is provided below in Table 4.2.4.2 & 4.2.4.3

b) The ice protection system – Pneumatic Deice System shall protect the leading edges of wing, vertical tail and horizontal tail against detrimental ice accumulation during aircraft flight in both continuous maximum and intermittent maximum icing conditions as defined in 14 CFR Part 25 Appendix C icing envelopes. The system shall be designed to provide for safe operation of the aircraft throughout the aircraft operating envelope.

c) Ice detection system shall have redundancy (minimum two independent ice detectors). Ice detectors location sensitivity study has to be carried by the Bidder to identify the optimal location on aircraft.

d) Ice Impingement Analysis has to be carried out:
   (i) Ice accretion studies on SARAS 19 seat aircraft during flight in various icing cloud conditions to determine impingement limits.
   (ii) Droplet impingement limit and ice accretion limit, can be used in the ice protection system development.
   (iii) The local droplet collection efficiency
   (iv) Ice detectors location on aircraft

e) Bidder shall evolve system architecture and select LRUs/Items such that in any applicable icing scenario adequate ice protection is available. This is to be ensured by the estimation of impingement limits (using means acceptable to buyer) by the system bidder and the boot dimensions to cover these limits.

f) The failure of system controller and LRUs/Items clubbed together as system failure shall be provided as a bit either Discrete or ARINC 429.

4.2.4.1 Structure Drawings from CSIR-NAL:

Drawings will be supplied that will allow the limiting dimensions of the De-Icer to be determined. Typical information for each component that needs ice protection will include:

1 Station references and rib locations.

2 True length of airfoil, as measured along centerline of the leading edge. The station reference numbers should be noted that provide the termination points of the established central line lengths.

3 Termination points (station numbers) of removable fairings, tip caps, landing light frames, as well as any other items that are periodically removed and should not be covered by a De-Icer.

If the De-Icer end profile is to be matched against any of the above items, the matching flat pattern profile of these items should be provided.

4 Structure drawings that will aid location of de-Icer air connections and associated plumbing. Each De-Icer shall be provided with one or two air connection clearance holes of up to 1.5-

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inch diameter through the airfoil skin. To allow De-Icer air connections to be located, drawings shall be provided that show rib locations, rib lightening hole sizes and locations, access plates.

5 Deicer covered areas that have compound curvature surfaces such as wing breaks. A plaster splash or actual airfoil section may be needed to make necessary tooling to produce De-Icer.

4.2.4.2 Airfoil Data

Location	Station (m)	Sweep (deg)	Airfoil	chord (m/in)	Incidence (deg)	Drawing file
Wing root (@ fuselage)	0.975	1.91	MS 317	2.35 m 92.52 in	1.76	Will be provided
MAC	3.925	1.91	MS 313	1.837 m 72.322 in	1.17	Will be provided
HT root	0	12.84	NACA 0012	1.6 m 63 in	-4 to +1.5 (variable)	
HT tip	3.045	12.84	NACA 0012	0.7 m 27.6 in	-4 to +1.5 (variable)	
Fin root (@ dorsal)	0.969*	74.87	NACA 0012	2.645 m 104.13 in	0	Will be provided
Transition point end of dorsal	1.507*	39	NACA 0012	2.492 m 98.11 in	0	
Fin tip	3.666*	39	NACA 0012	1.876 m 74 in	0	

Wing, VT and HT airfoil drawings will be provided.

4.2.4.3 Flight Conditions for Impingement analysis

Flight	Altitude	Airspeed		Fuselage Angle of Attack	Wing root AoA	Wing tip AoA	HT AoA
Condition	ft	KCAS	KTAS	deg	deg	deg	deg
Normal Climb	7500	130	145	6.1	10.1	6.6	0.27
Normal Climb	12500	130	157	6	10	6.5	0.20
Normal Cruise	15,000	172	215	2.1	6.1	2.6	-2.53
Normal Cruise	25,000	146	216	3.9	7.9	4.4	-1.27
Max Cruise	25,000	180	265	1.6	5.6	2.1	-2.88
Minimum Cruise (or hold)	8000	120	135	6.9	10.9	7.4	0.83
Normal Descent	7500	130	145	5.5	9.5	6	-0.15
Normal Descent	12500	130	157	5.5	9.5	6	-0.15

4.2.5 Maintainability, Reliability and Product Support

a) Shelf life, Time Between Overall (TBO), and Total Technical life (TTL) should be commensurate with industry standards and should be as high as possible. Values of Shelf life, Time Between Overall (TBO), and Total Technical life (TTL) for the LRUs/Items shall be specified by the bidder based upon technology maturity level.

b) All LRUs/Items shall have high MTBF to meet system safety and reliability requirements for the proposed system architecture as per FAR 23.1309 amendment 23-64.

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c) Bidder shall provide on-site and off-site product support for technical inputs to certification and ground test, flight test activities.

d) Bidder should ensure all quoted Pneumatic Deice system LRUs/Items should be available for 30 years.

4.2.6 **List of Deliverables:**

Sr. No.	Item Description	Unit	Quantity
1	Design, Development of Pneumatic Deice System - Leading Edges of Wing, VT and HT. The detail break-up of Design, Development of Pneumatic Deice System to be quoted in a separate list (pdf format) which comprises the total cost.	No	1
2	Supply of Pneumatic Deice System - Leading Edges of Wing, VT and HT. The individual LRUs/Items of Pneumatic Deice System to be quoted in a separate list (pdf format) which comprises the total cost of a shipset	Shipset	4

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4.3 Detailed Specifications

4.3.1 PART B: Leading Edges of Wing, VT and HT and Engine Air Intake Lip

Pneumatic Deice system should meet FAR-23 amendment 23-64 performance-based regulations. The prescriptive provisions within previous amendment 63 of FAR-23, where applicable, may be used at aircraft ambient air temperatures from -55°C to +70°C. Qualification tests of the system components/LRUs to conform to RTCA DO-160D or above upto RTCA DO-160G / Equivalent		
1.	**Areas for Deicing (values given are approximate and are as suggestions only. Supplier to confirm against calculations or analysis)**	
a)	Wing leading edge (L.H. and R.H.) (Typical)	LH-0.52 m^2 (IB), 0.89 m^2 (C), 0.94 m^2 (OB), RH-0.52 m^2 (IB), 0.89 m^2 (C), 0.94 m^2 (OB)
b)	Horizontal stabilizer leading edge (L.H. and R.H.) (Typical)	LH:0.84 m^2; RH:0.84 m^2
c)	Vertical stabilizer leading edge (Typical)	0.44 m^2
d)	Engine air intake lips (LH and RH) (Typical)	LH = 0.6 m^2; RH = 0.6 m^2
2.	**Engine bleed air supply to the deice system**	
a)	Temperature range	min 40 deg C & max 100 deg C
b)	Pressure range	32 ± 3 psig
c)	Maximum permissible instantaneous mass flow rate demand	4 lb/min (operational mode of de-ice system) 1 lb/min (non-operational mode of de-ice system, for continuous vacuum suction of boots)
3.	**Inflatable rubber boot specification (Typical and given as suggestions only)**	
a)	Material	Fabric reinforce rubber sheet containing inflatable tubes
b)	Width of tube	25 mm
c)	Max. thickness	2.5 mm
d)	Weight	Not more than 2.25 kg per sq. m (total weight with this specification is ~18kg)
e)	Max. pressure	21 psig
f)	Temperature range (survival)	-55° C to +100° C
g)	Vacuum	2 to 5 psig to maintain the de-ice tube tubes in a flat or deflated condition
h)	Electrical	Deice: maximum 6.3 amps @ 28 V DC
i)	i. Mechanical equipment for regulating the deicer operating bleed air coming from Bleed system of Precooler heat exchanger. ii. Electro-Mechanical equipment to control the deicing system. iii. Deice system should have I-BIT feature. System Controller should indicate built in failure of components (For example: Timer, Ejector Flow Control Valves etc.) in the form of ARINC 429 or Discreate. iv. Ice detection system supplied as a part of pneumatic deicing system shall detect ice formation accurately v. The Deice system shall accept all the signals from the control panel in their native form. vi. All signal outputs from Deice system (its components and sensors) shall be compatible to ARINC 429 communication protocol. vii. Two ARINC 429 output channels shall be provided, for redundant purpose.	

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	viii.	Other required components for the functioning of Deice System shall be included.
	ix.	Individual Component Dimensional Drawings with weight shall be provided.
	x.	The proposed system shall be based on components/LRUs as far as possible off the shelf brand new with long lead service life and on condition maintenance.
j)	Proof Pressure: 1.5 times of System Design Pressure Burst Pressure: 3 times of System Design Pressure	

Note: The wing, H.T. and V.T are made of composite materials.

4.3.2 Full Qualification Tests.

(i) Off The shelf- LRUs documents supporting means of compliance of qualification tests as per RTCA DO-160D or above upto RTCA DO-160G / Equivalent, means of compliance of Acceptance & Performance Tests, Endurance Test documents supporting means of compliance to meet the useful life of 30 years or 30000 flying hours have to be submitted to CSIR-NAL.
(Request bidder to provide means of compliance of qualification tests details, Acceptance & Performance Tests and Endurance Test as part of bid submission).

(ii) LRUs to be designed and developed to meet CSIR-NAL Pneumatic Deice system specifications & requirements, qualification schedules as per RTCA DO-160D or above upto RTCA DO-160G / Equivalent, Acceptance & Performance Tests schedules have to be submitted to CSIR-NAL. Endurance Test and its pass/fail criteria has to be proposed by bidder as per Pneumatic Deice system bidder's standard practices to meet the useful life of 30 years or 30000 flying hours and endurance test schedules have to be submitted to CSIR-NAL.
(Request Bidder to provide means of compliance of qualification tests plan details, Acceptance & Performance Tests plan details and Endurance Test plan details as part of bid submission).

The following tests shall be performed on the Pneumatic Deice system LRUs as part of Full Qualification Test.

a) Acceptance & Performance Tests

- Initial Visual Examination and Measurement of Weight and Physical Parameters
- Performance/Functional Checks
- Thermal Shock
- Thermal Performance and Pressure Drop
- Endurance Test

b) Environmental Tests (Qualification tests as per RTCA DO-160D or above upto RTCA DO-160G / Equivalent)

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Table1: Environmental Qualification Map of Pneumatic Deice System Items/LRUs as per RTCA DO-160D or above up to RTCA Do-160G

Requirements	RTCA DO-160	Item - Ice Detector	Items - With Electrical Interface	Items - Without Electrical Interface
Location		Nose Cone (Uncontrolled Pressure and uncontrolled Temperature)	Centre wing Forward Faring (Uncontrolled Pressure and uncontrolled Temperature)	Centre wing Forward Faring (Uncontrolled Pressure and uncontrolled Temperature)
Temperature and Altitude	Section 4	Category C4: Operating Low Temp (OLT): Soak at -40 deg C for 3 hours minimum and operate at -40 degC for 30 minutes: Operating High Temp (OHT): +55 degC: Altitude: 30000 feet.	Category C4: Operating Low Temp (OLT): Soak at -40 deg C for 3 hours minimum and operate at -40 degC for 30 minutes: Operating High Temp (OHT): +55 degC: Altitude: 30000 feet.	Category C4: Operating Low Temp (OLT): Soak at -40 deg C for 3 hours minimum and operate at -40 degC for 30 minutes: Operating High Temp (OHT): +55 degC: Altitude: 30000 feet.
Temperature Variation	Section 5	Category B : Rate of change of Temperature: 5 degC per minute; Operating Low Temp (OLT): -40 degC: Operating High Temp (OHT): +55 degC.	Category B: Rate of change of Temperature: 5 degC per minute; Operating Low Temp (OLT): -40 degC: Operating High Temp (OHT): +55 degC.	Category B: Rate of change of Temperature: 5 degC per minute: Operating Low Temp (OLT): -40 degC: Operating High Temp (OHT): +55 degC.
Humidity	Section 6	Category C: Temperature: 38±2 to 65±2 (deg C); Humidity: 85±4 to 95±4 (% RH); Number of Cycles: 6 Days (144 Hours of exposure)	Category B: Temperature: 38±2 to 65±2 (deg C); Humidity: 85±4 to 95±4 (% RH); Number of Cycles: 10 Days (240 Hours of exposure).	Category B: Temperature: 38±2 to 65±2 (deg C); Humidity: 85±4 to 95±4 (% RH); Number of Cycles: 10 Days (240 Hours of exposure).
Operating Shock and Crash Safety	Section 7	Category B: OS: 6g for 11 ms; CS: 20g for 11ms: Crash Safety Sustained (Structural linear acceleration): 9g in all direction for Random orientation.	Category B: OS: 6g for 11 ms: CS: 20g for 11ms: Crash Safety Sustained (Structural linear acceleration): 9g in all direction for Random orientation.	Category B: OS: 6g for 11 ms: CS: 20g for 11ms: Crash Safety Sustained (Structural linear acceleration): 9g in all direction for Random orientation.
Vibration Endurance	Section 8	Cat. S, Test Curve M	Cat. S, Test Curve L: Standard Sinusoidal Vibration Test is DESIRABLE: Dwell time of 15 minutes is DESIRABLE at each severe frequency selected from the critical frequencies.	Cat. S, Test Curve L: Standard Sinusoidal Vibration Test is DESIRABLE: Dwell time of 15 minutes is DESIRABLE at each severe frequency selected from the critical frequencies.
Explosive Proofing	Section 9	Category H, Category Zone III: Component shall be tested for the thermal ignition in the operating range +65 to +260 degC.	Category H, Category Zone III: Component shall be tested for the thermal ignition in the operating range +65 to +260 degC.	Category H, Category Zone III: Component shall be tested for the thermal ignition in the operating range +65 to +260 degC.
Water-proofing	Section 10	Category Y: Equipment OFF: Low Temp: -10 degC & 85% RH, stabilize for 3 hours. Operating: at High Temp: +40 degC & 85% RH, operate for 10 minutes	Category Y: Equipment OFF: Low Temp: -10 degC & 85% RH, stabilize for 3 hours. Operating: at High Temp: +40 degC & 85% RH, operate for 10 minutes	Category Y: Equipment OFF: Low Temp: -10 degC & 85% RH, stabilize for 3 hours. Operating: at High Temp: +40 degC & 85% RH, operate for 10 minutes
Fluids Susceptibility	Section 11	Category F: Spray test: Wetting for 8 hours followed by a drying period of 16 hours at 65 degC. Number of cycles: Three 24-four hours cycles	Category F: Spray test: Wetting for 8 hours followed by a drying period of 16 hours at 65 degC. Number of cycles: Three 24-four hours cycles	Category F: Spray test: Wetting for 8 hours followed by a drying period of 16 hours at 65 degC. Number of cycles: Three 24-four hours cycles
Sand and Dust	Section 12	Category D Dust test: 3.5 to 8.8g/m3 and 97 to 99% silicon dioxide, air velocity is 0.5 to 2.4 m/s;	Category D Dust test: 3.5 to 8.8g/m3 and 97 to 99% silicon dioxide, air velocity is 0.5 to 2.4 m/s;	Category D Dust test: 3.5 to 8.8g/m3 and 97 to 99% silicon dioxide, air velocity is 0.5 to 2.4 m/s;
Fungus Resistance	Section 13	Category F: Incubation at +30 degC and 97±2% RH, for 28 days after satisfactory fungus growth.	Category F: Incubation at +30 degC and 97±2% RH, for 28 days after satisfactory fungus growth.	Category F: Incubation at +30 degC and 97±2% RH, for 28 days after satisfactory fungus growth.
Salt Spray	Section 14	Category S: 24 hours' exposure to salt fog and 24 hours dry at ambient with 50%RH; Number of cycles: 2	Category S 24 hours' exposure to salt fog and 24 hours dry at ambient with 50%RH; Number of cycles: 2	Category S: 24 hours' exposure to salt fog and 24 hours dry at ambient with 50%RH: Number of cycles: 2
Magnetic Effect	Section 15	Category A :0.3m < D ≤ 1m	Category C : D > 3.0m	Category C: D > 3.0m
Power Input	Section 16	Category B: Normal Operating Tests: 30.3 V, 22.0 V & 18.0 V; Momentary Power Interruption Test: Interruption 50 ms;	Category B: Normal Operating Tests: 30.3 V, 22.0 V & 18.0 V; Momentary Power Interruption Test: Interruption 50 ms;	Category B: Normal Operating Tests: 30.3 V, 22.0 V & 18.0 V; Momentary Power Interruption Test: Interruption 50 ms;
Voltage Spike	Section 17	Category A: Minimum of 50 positive polarity transients within a period of one minute; Repeat the application with 50 negative polarity transients within a one-minute period.	Category A: Minimum of 50 positive polarity transients within a period of one minute; Repeat the application with 50 negative polarity transients within a one-minute period.	Category A: Minimum of 50 positive polarity transients within a period of one minute; Repeat the application with 50 negative polarity transients within a one-minute period.
Audio Frequency Conducted Susceptibility - Power Input	Section 18	Category B	Category B	NA
Induced Signal Susceptibility	Section 19	Category ZCE: Magnetic Fields Induced into the Equipment: 20 A rms at 400 Hz; Magnetic Fields Induced into Interconnecting Cables: IxL=30 A-m at 400Hz reducing to 0.8 A-m at 15kHz Electric Fields Induced into Interconnecting Cables: VxL=1800 V-m from 380 to 420Hz; Spikes Induced into Interconnecting Cables: Cable length: 3m/ 3m/ 1.2m Amplitude 600V p-p Duration: 50- 1000µs Repetition rate 0.2 to 10µs.	Category ZCE: Magnetic Fields Induced into the Equipment: 20 A rms at 400 Hz; Magnetic Fields Induced into Interconnecting Cables: IxL=30 A-m at 400Hz reducing to 0.8 A-m at 15kHz. Electric Fields Induced into Interconnecting Cables: VxL=1800 V-m from 380 to 420Hz; Spikes Induced into Interconnecting Cables: Cable length: 3m/ 3m/ 1.2m Amplitude 600V p-p Duration: 50- 1000µs Repetition rate 0.2 to 10µs.	Category ZCE: Magnetic Fields Induced into the Equipment: 20 A rms at 400 Hz; Magnetic Fields Induced into Interconnecting Cables: IxL=30 A-m at 400Hz reducing to 0.8 A-m at 15kHz Electric Fields Induced into Interconnecting Cables: VxL=1800 V-m from 380 to 420Hz; Spikes Induced into Interconnecting Cables: Cable length: 3m/ 3m/ 1.2m Amplitude 600V p-p Duration: 50- 1000µs Repetition rate 0.2 to 10µs.
Radio Frequency Susceptibility (Radiated and Conducted)	Section 20	Category RR: Conducted Susceptibility: Conducted: 30 mA; Radiated Susceptibility: Electric Field: 100 V/m.	Category RR: Conducted Susceptibility: Conducted: 30 mA; Radiated Susceptibility: Electric Field: 100 V/m.	Category RR: Conducted Susceptibility: Conducted: 30 mA; Radiated Susceptibility: Electric Field: 100 V/m.
Emission of Radio Frequency Energy	Section 21	Category L: Conducted RF Emissions: 150 KHz to 152 MHz.; Radiated RF Emission Category L 100 MHz to 6000 MHz	Category H: Conducted RF Emissions: 150 KHz to 152 MHz; Radiated RF Emission: 100 MHz to 6000 MHz.	NA
Lightning Induced Transient Susceptibility	Section 22	A3XX as per DO-160D OR A3E3L3 or A3XXXX as per DO-160G	A3XX as per DO-160D OR A3E3L3 or A3XXXX as per DO-160G	NA
Lightning Direct Effects	Section 23	Category ZZ1A	Category ZZ2A	NA
Icing	Section 24	Category C: Uniform water spray for 1 hour.	NA	NA
Electrostatic Discharge Requirements	Section 25	Category A: ESD pulses at a test level of 15000 volts	Category A: ESD pulses at a test level of 15000 volts	NA
Fire, Flammability	Section 26	Category C: Testing is not necessary	Category C: Testing is not necessary	NA

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4.3.3 Pneumatic Deice System of Saras Mk II with Pneumatic Deicers - Leading Edges of Wing, VT, HT and Engine Air Intake Lip

Figure 1 shows Saras Mk II Aircraft with Pneumatic Deicers. Bleed System/Pneumatic System is shown for reference. The Bidder shall propose suitable architecture based on off-the-shelf items as far as possible to meet the requirements of System specifications and safety, Reliability requirements as per FAR 23.1309 amendment 23-64. Ice detectors location shall be identified by the Bidder.

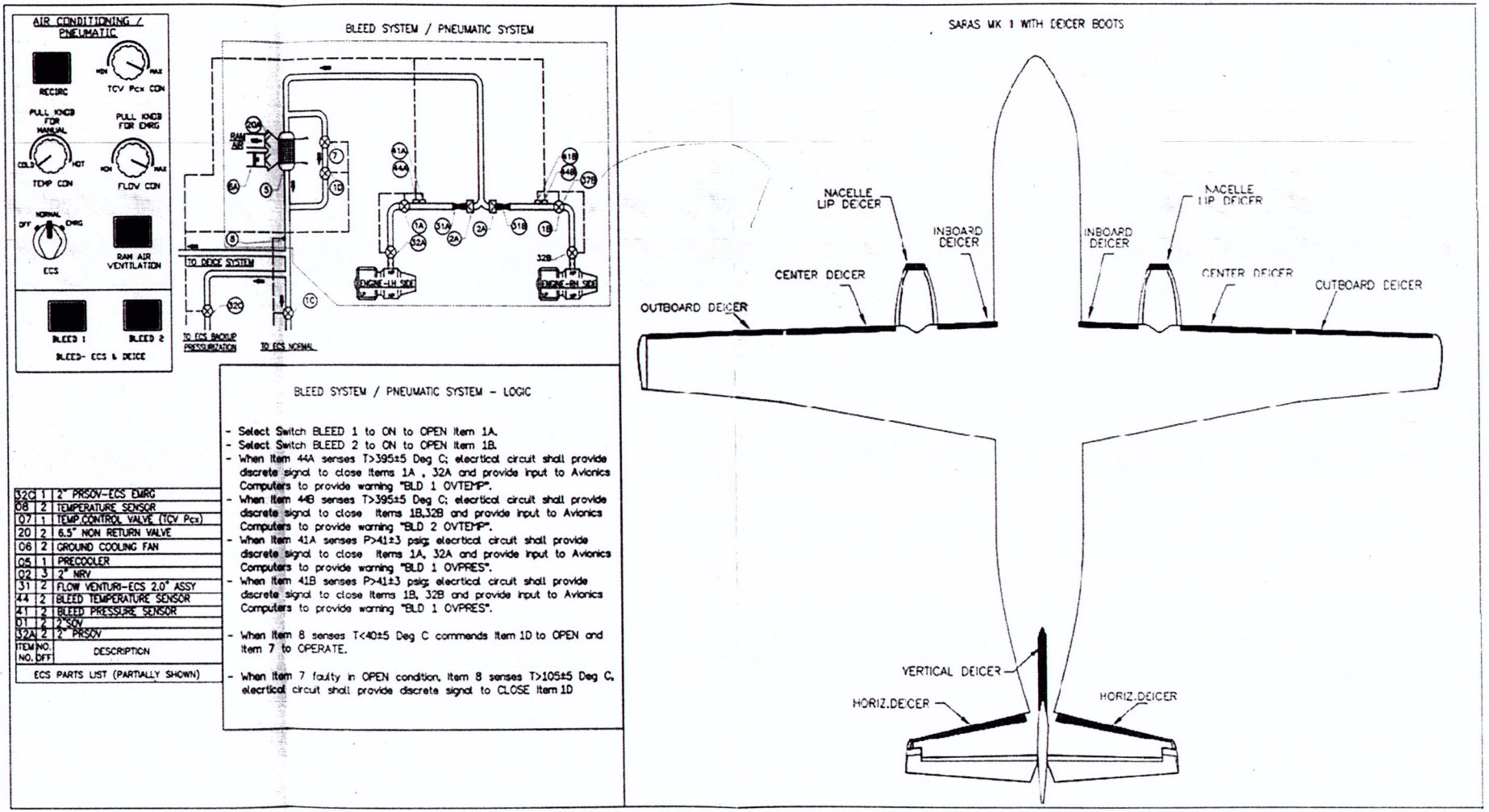

Figure 1: Saras Mk II Aircraft with Pneumatic Deicers - Leading Edges of Wing, VT, HT and Engine Air Intake Lip

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4.3.3.1 Bleed System:

Bleed air is supplied to Pneumatic Deice System. Bleed Air System operated after Engines start at and above Flight Idle (FI) onwards only. The Bleed air system has control valves near Engine 1 and 2 and NRVs near T-joint of Bleed line from Engine 1 and 2. The Bleed air system has Venturi meter with flow sensor. Because of the limit imposed by engine group the system should ensure that at no flight condition more than 21 lb/min bleed flow shall not be drawn from engines. There is a common Precooler heat exchanger for ECS Normal System, Emergency Backup Pressurization System and Deice System. Precooler is cooled by coolant air supplied by ground cooling fan on ground and by ram air in flight. The bleed system shall have TCV driven by pass logic to ensure the Precooler outlet temperature after bypassing shall be in the range of 40 to 100 deg C, to meet the requirements of the pneumatic deice system.

4.3.4 Requirements of Pneumatic Deice System - Leading Edges of Wing, VT, HT and Engine Air Intake Lip

a) The icing impingement analysis (FAA Part 23, Section 23.1419) shall be performed on the Wing, Vertical Tail (VT), Horizontal Tail (HT) and Engine Air Intake Lip of the NAL SARAS Mk II aircraft. The analysis shall be performed using appropriate (industry standard) Ice Accretion Code. The purpose of the analysis is to define the extents of icing impingement in order to estimate the pneumatic deicer coverage required to provide adequate ice protection. Flight conditions and airfoil data to be used in the analysis is provided below in Table 4.3.4.2, 4.3.4.3 & 4.3.4.4

b) The ice protection system –Pneumatic De-icing System shall protect the leading edges of wing, vertical tail, horizontal tail and Engine Air Intake Lip against detrimental ice accumulation during aircraft flight in both continuous maximum and intermittent maximum icing conditions as defined in 14 CFR Part 25 Appendix C icing envelopes. The system shall be designed to provide for safe operation of the aircraft throughout the aircraft operating envelope.

c) Ice detection system shall have redundancy (minimum two independent ice detectors). Ice detectors location sensitivity study has to be carried by the Bidder to identify the optimal location on aircraft.

d) Ice Impingement Analysis has to be carried out:
   i. Ice accretion studies on SARAS 19 seat aircraft during flight in various icing cloud conditions to determine impingement limits.
   ii. Droplet impingement limit and ice accretion limit, can be used in the ice protection system development.
   iii. The local droplet collection efficiency
   iv. Ice detectors location on aircraft

e) Bidder shall evolve system architecture and select LRUs/components such that in any applicable icing scenario adequate ice protection is available. This is to be ensured by the estimation of impingement limits (using means acceptable to buyer) by the system vendor and the boot dimensions to cover these limits.

f) The failure of system controller and components club together as system failure shall be provided as a bit either Discrete or ARINC 429.

4.3.4.1 Structure Drawings from CSIR-NAL:

1 Drawings will be supplied that will allow the limiting dimensions of the Deicer to be determined. Typical information for each component that needs ice protection will include: Station references and rib locations.

2 True length of airfoil, as measured along centerline of the leading edge. The station reference numbers should be noted that provide the termination points of the established central line lengths.

3 Termination points (station numbers) of removable fairings, tip caps, landing light frames, as well as any other items that are periodically removed and should not be covered by a Deicer.
If the Deicer end profile is to be matched against any of the above items, the matching flat pattern profile of these items should be provided.

4 Structure drawings that will aid location of Deicer air connections and associated plumbing. Each Deicer shall be provided with one or two air connection clearance holes of up to 1.5inch diameter through the airfoil skin. To allow Deicer air connections to be located, drawings

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shall be provided that show rib locations, rib lightening hole sizes and locations, access plates.

5 Deicer covered areas that have compound curvature surfaces such as wing breaks. A plaster splash or actual airfoil section may be needed to make necessary tooling to produce Deicer.

4.3.4.2 Airfoil Data

Location	Station (m)	Sweep (deg)	Airfoil	Chord (m/in)	Incidence (deg)	Drawing file
Wing root (@ fuselage)	0.975	1.91	MS 317	2.35 m 92.52 in	1.76	Will be provided
MAC	3.925	1.91	MS 313	1.837 m 72.322 in	1.17	Will be provided
HT root	0	12.84	NACA 0012	1.6 m 63 in	-4 to +1.5 (variable)	
HT tip	3.045	12.84	NACA 0012	0.7 m 27.6 in	-4 to +1.5 (variable)	
Fin root (@ dorsal)	0.969*	74.87	NACA 0012	2.645 m 104.13 in	0	Will be provided
Transition point end of dorsal	1.507*	39	NACA 0012	2.492 m 98.11 in	0	
Fin tip	3.666*	39	NACA 0012	1.876 m 74 in	0	

Wing, VT and HT airfoil drawings will be provided.

4.3.4.3 Engine Air Intake Lip data

Pitot type inlet configuration is selected for SARAS Mk II aircraft. The preliminary nacelle air intake lip layout is shown in figure 2. Pneumatic deicer boots to conform to predicted impingement limits computed by vendor.

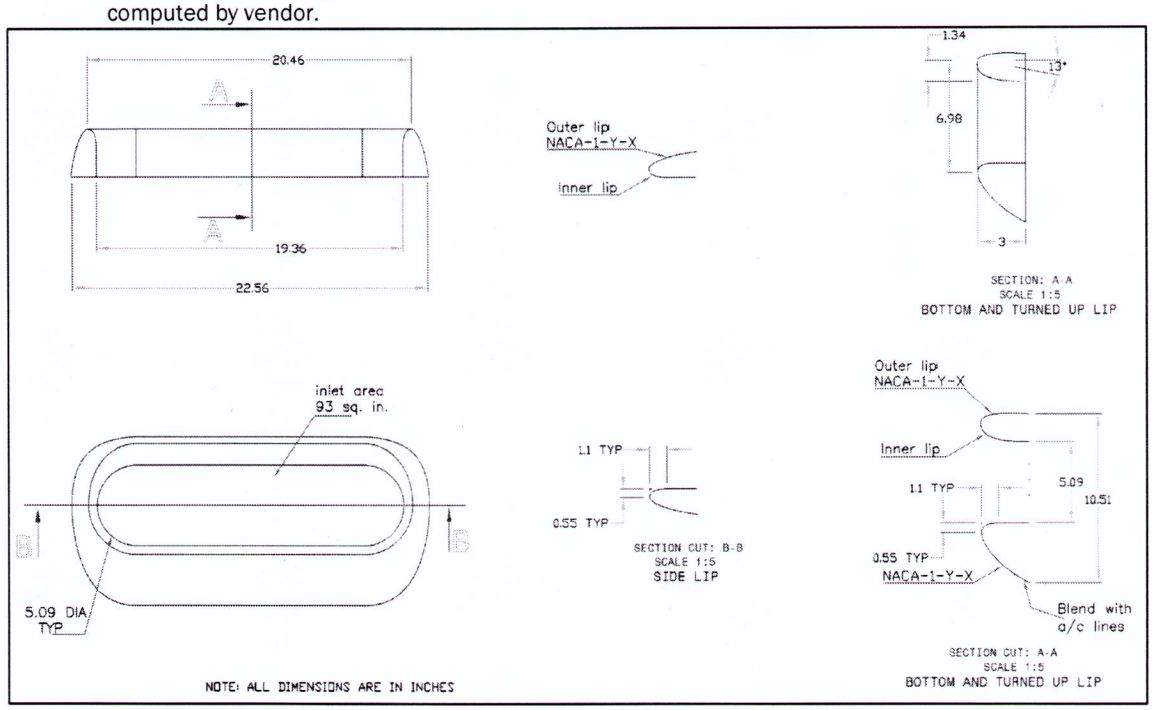

Figure 2: Saras Mk II Aircraft - Engine Air Intake Lip

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4.3.4.4 Flight Conditions for Impingement analysis

Flight	Altitude	Airspeed		Fuselage Angle of Attack	Wing root AoA	Wing tip AoA	HT AoA
Condition	ft	KCAS	KTAS	deg	deg	deg	deg
Normal Climb	7500	130	145	6.1	10.1	6.6	0.27
Normal Climb	12500	130	157	6	10	6.5	0.20
Normal Cruise	15,000	172	215	2.1	6.1	2.6	-2.53
Normal Cruise	25,000	146	216	3.9	7.9	4.4	-1.27
Max Cruise	25,000	180	265	1.6	5.6	2.1	-2.88
Minimum Cruise (or hold)	8000	120	135	6.9	10.9	7.4	0.83
Normal Descent	7500	130	145	5.5	9.5	6	-0.15
Normal Descent	12500	130	157	5.5	9.5	6	-0.15

4.3.5 Maintainability, Reliability and Product Support

a) Shelf life, Time Between Overall (TBO), and Total Technical life (TTL) should be commensurate with industry standards and should be as high as possible. Values of Shelf life, Time Between Overall (TBO), and Total Technical life (TTL) for the LRUs/Items shall be specified by the bidder based upon technology maturity level.

b) All LRUs/Items shall have high MTBF to meet system safety and reliability requirements for the proposed system architecture as per FAR 23.1309 amendment 23-64.

c) Bidder shall provide on-site and off-site product support for technical inputs to certification and ground test, flight test activities.

d) Bidder should ensure all quoted Pneumatic Deice system LRUs/Items should be available for 30 years.

4.3.6 List of Deliverables:

Sr. No.	Item Description	Unit	Quantity
1	Design, Development of Pneumatic Deice System - Leading Edges of Wing, VT, HT and Engine Air Intake Lip The detail break-up of Design, Development of Pneumatic Deice System to be quoted in a separate list (pdf format) which comprises the total cost.	No	1
2	Supply of Pneumatic Deice System - Leading Edges of Wing, VT, HT and Engine Air Intake Lip The individual LRUs/Items of Pneumatic Deice System to be commercially quoted in a separate list (pdf format) which comprises the total cost of a shipset.	Shipset	4

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4.4 **List of Documentation: [for both PART-A & PART-B]**

"Bidder shall supply all signed documents mentioned below in 2 sets of hard copies and soft copy of the same".

Sl. No	Item Description
1.	Supply of manuals system level and LRU level
2.	Applicable steady state and transient performance characteristics of all LRUs/ Items
3.	System Level performance report
4.	Ice Impingement Analysis report - (i) Ice accretion studies on SARAS 19 seat aircraft during flight in various icing cloud conditions to determine impingement limits. (ii)Droplet impingement limit and ice accretion limit, can be used in the ice protection system development. (iii)The local droplet collection efficiency. (iv) Ice detectors location on aircraft.
5.	LRU level test schedules to carry out pre-installation checks of all mechanical, electrical and electronic components.
6.	Components/LRUs Life document: Shelf life, TBO, Service Life and Storage Condition etc.
7.	System Reliability Analysis (RBA)
8.	Functional Hazard Analysis (FHA)
9.	Failure Mode Effects and Criticality Analysis (FMECA)
10.	Fault Tree Analysis (FTA)
11.	Installation and interface drawings (Mechanical/Electrical)
12.	Component/LRU design specification
13.	Qualification test procedures (QTP)
14.	Qualification test report (QTR)
15.	Acceptance test procedure (ATP)
16.	Acceptance test reports (ATR)
17.	COC/ FAA Form /EASA Form One or Equivalent
18.	Declaration of Design and Performance (DDP)
19.	Operating instructions and first line maintenance instructions/ Component Maintenance Manual/Overhaul Manual
20.	Wiring diagrams
21.	Recommendations for ground support equipment
22.	Spares recommendation list
23.	ARINC 429 channel ICD

4.5 **Services**

(i) Participation in the preliminary design review (PDR) and the Critical design review (CDR) to be held at CSIR-NAL Bangalore.

(ii) CSIR-NAL Team and Certification agency shall witness Qualification testing of System LRUs at Bidder's place. (if any LRUs going to develop to meet requirements of Pneumatic Deice System) If requested by CSIR-NAL; Bidder shall also provide engineering support during the integration of the Pneumatic Deice system onto the Aircraft, including making an engineer available in India for a period not exceeding 5 working days (CSIR-NAL to provide office accommodation, local transport and communication facilities).

4.6 **Scope of Supply and incidental works:**

Scope of Supply includes the following:

(i) Design, Development and Supply of Pneumatic Deice system as per the System Level Specifications & Requirements along with the accessories as per clause No.4.2 (Part A) and 4.3 (Part B)

(ii) Installation, Commissioning and Acceptance as per clause No.4.7.3

(iii) Training as per clause No.4.8

(iv) On site comprehensive Warranty as per clause No.4.9

(v) Delivery Schedule as per clause No.4.10

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CSIR-NAL Responsibilities:

1. Aircraft System Level Specifications and Requirements.
2. Review of Performance report of system supplied by Bidder/Vendor.
3. System Installation design and Integration on aircraft.
4. Aircraft System level performance tests on ground and in flight.
5. Certification of system on aircraft in coordination with certifying regulatory authorities.

Bidders Responsibilities:

1. Pneumatic Deice System Architecture shall propose by Bidder and finalization by both CSIR-NAL and Bidder.
2. Supply of list of documents mentioned in Para 4.4
3. Design, Development and Supply of 4 Nos shipments of Pneumatic Deice System (Preference to be given to incorporate off the shelf LRUs as far as possible brand new LRUs with long lead shelf life and service life and on condition maintenance)
4. Performance report of Pneumatic Deice System.
5. Review of System Installation design and Integration on aircraft.
6. Review of Aircraft System level performance test schedules and reports on ground and in flight.
7. Technical Support during certification of system on aircraft in coordination with certification regulatory authorities (This would be a separate contract at a later stage, after the airplane basic certification is completed).
8. Supply of Sub systems/ LRUs of Pneumatic Deice system and Support for Service of LRUs on need basis.
9. Bidder shall facilitate auditing of manufacturing facility by NAL/NAL representatives /Certification Authority.

4.7 Inspection & Tests

4.7.1 General

1. The Supplier shall at its own expense and at no cost to the Purchaser carry out all such tests and/or inspections of the Goods and Related Services as are specified here.

2. The inspections and tests may be conducted on the premises of the Supplier or its subcontractor(s), at the point of delivery and/or at the Goods final destination.

3. Whenever the Supplier is ready to carry out any such test and inspection, it shall give a reasonable advance notice, including the place and time, to the Purchaser. The Supplier shall obtain from any relevant third party or manufacturer/sub-contractor any necessary permission or consent to enable the Purchaser or its designated representative of CSIR-NAL and/or Certification Authorities to attend the test and/or inspection.

4. Should any inspected or tested Goods fail to conform to the specifications, the Purchaser may reject the goods and the Supplier shall either replace the rejected Goods or make alterations necessary to meet specification requirements free of cost to the Purchaser.

5. The Purchaser's right to inspect, test and, where necessary, reject the Goods after the Goods' arrival at final destination shall in no way be limited or waived by reason of the Goods having previously been inspected, tested and passed by the Purchaser or its representative prior to the Goods shipment.

6. The Supplier shall provide the Purchaser with a report of the results of any such test and/or inspection.

7. With a view to ensure that claims on insurance companies, if any, are lodged in time, the bidders and /or the Indian agent, if any, shall be responsible for follow up with their principals for ascertaining the dispatch details and informing the same to the Purchaser and he shall also liaise with the Purchaser to ascertain the arrival of the consignment after customs clearance so that immediately thereafter in his presence the consignment could be opened and the insurance claim be lodged, if required, without any loss of time. Any delay on the part of the bidder/ Indian Agent would be viewed seriously and he shall be directly responsible for any loss sustained by the purchaser on the event of the delay.

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8. Before the goods and equipment are taken over by the Purchaser, the Supplier shall supply operation and maintenance Manuals together with Drawings of the goods and equipment built. These shall be in such details as will enable the Purchase to operate, maintain, adjust and repair all parts of the works as stated in the specifications.

9. The Manuals and Drawings shall be in the ruling language (English) and in such form and numbers as stated in the Contract.

10. Unless and otherwise agreed, the goods and equipment shall not be considered to be completed for the purposes of taking over until such Manuals and Drawing have been supplied to the Purchaser.

11. On successful completion of acceptability test, receipt of deliverables, etc. and after the Purchaser is satisfied with the working of the equipment, the acceptance certificate signed by the Supplier and the representative of the Purchaser will be issued. The date on which such certificate is signed shall be deemed to be the date of successful commissioning of the equipment.

4.7.2 Manufacturer's Inspection Certificate

After the goods are manufactured and assembled, inspection and testing of the goods shall be carried out at the supplier's plant by the supplier, prior to shipment to check whether the goods are in conformity with the technical specifications. Manufacturer's test certificate with data sheet shall be issued to this effect and submitted along with the delivery documents. The purchaser reserves the options to be present at the supplier's premises during such inspection and testing.

4.7.3 Installation, Commissioning and Acceptance Test

The acceptance test will be conducted by the Purchaser, their consultant or other such person nominated by the Purchaser at its option after the equipment is installed at Purchaser's site in the presence of supplier's representatives. The acceptance will involve trouble free operation. There shall not be any additional charges for carrying out acceptance test. No malfunction, partial or complete failure of any part of the equipment is expected to occur. The Supplier shall maintain necessary log in respect of the result of the test to establish to the entire satisfaction of the Purchaser, the successful completion of the test specified.

On the event of the ordered item failing to pass the acceptance test, a period not exceeding two weeks will be given to rectify the defects and clear the acceptance test, failing which, the Purchaser reserve the right to get the equipment replaced by the Supplier at no extra cost to the Purchaser.

Successful conduct and conclusion of the acceptance test for the installed goods and equipment shall also be the responsibility and at the cost of the Supplier.

The acceptance tests at the final destination include the following:

a)	Visual Inspection
b)	Leakage Tests
c)	Room Temperature Functional/Performance Tests
d)	Bonding & Insulation Tests

4.8 Training

1)	Location	CSIR-National Aerospace Laboratories
2)	Number of persons	06
3)	Period of Training	05 Days
4)	Nature of Training	System Functionality / Performance / implementation / Testing / Maintenance & Service.

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4.9 Incidental Services

(i) **On site Comprehensive Warranty:**

- 2 Years from Installation & Commissioning and date of acceptance
- In case the Equipment / System remains non-operational for more than **30 days** then warranty period will be extended for the equivalent period for which Equipment / System remained non-operational. Warranty extension in such case shall be done without prejudice to any other Term & condition of the contract.

4.10 Delivery Schedule (including Supply, Installation, Commissioning & Acceptance)

Delivery of the Item from the date of PO/LC		Installation, Commissioning & Training		Acceptance of the item
Days/ Weeks/Months	Location	Days/ Weeks/Months from the date of receipt of item	Location	Days / Weeks / Months from the date of Installation, Commissioning & Training
Fully qualified 4 shipsets by 18 months	CSIR-NAL, Bangalore	1 Month	CSIR-NAL, Bangalore	1 Month

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CSIR-NATIONAL AEROSPACE LABORATORIES
BENGALURU

COMMERCIAL QUERIES & CLARIFICATION

Tender No. : NAL/PUR/CAD/373/20-Z [G]
`Item Description : Design, Development and Supply of Pneumatic Deicing System.

Query / Clarification Sought	Clarification/Amendment
— NIL —	

17/02/2022

Stores & Purchase Officer
For and on behalf of CSIR