NAL/PUR/CAD/373/20-Z[G] 28-Feb-2023

Tender Id: 2023_CSIR_697818_1

PROCEEDINGS OF THE PRE-BID CONFERENCE HELD ON 22-FEB-2023 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, RNCAC	Member
4	Mr. Vineet Kumar	Chief Scientist, RNCAC	PD-SARAS Member
5	Mr. C. A. Vinay	Principal Scientist, RNCAC	Specialist Member
6	Mr. Bhaskar Chakravarthy	Chief Scientist, RNCAC	Specialist Member
7	Mr. Lakshminarayana	Chief Scientist, RNCAC	Invitee and PL
8	Mr. Malisetty Leela Shankar	Sr. Principal Scientist, RNCAC	IO and Member - Convener (TSC)
9	COA or his/her representative		Member
10	COFA or his/her representative		Member
11	Mr Ramdas Tulshiram Pagare, SO (SP) (CoSP or his representative)		Member - Convener (T&PC)

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 Bidder (M/s Collins Aerospace) and briefed in general the scope of the Project. The Indenting Officer to read out the clarification sought by the bidders while going through Chapter 4 and the replied there to as detailed in **Annexure-II (Part A: Technical Clarification and Part B: Commercial Clarification).**

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 CPP portal/website of CSIR-NAL and prospective bidder is 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.

CoSP
Member–Convener (TPC)

CoFA
Member-Finance & Accounts

AO
Member- Admin

J. Ramaswamy Setty
Member

Dilip Kumar Sahu
Member

Vineet Kumar
Member, PD-SARAS MkII

C. A. Vinay
Specialist Member

Bhaskar Chakravarthy
Specialist Member

Lakshminarayana
Invitee & PL

Malisetty Leela Shankar
IO

Dr. M. Manjuprasad
Chairman-T&PC

Annexure-II

CSIR-NATIONAL AEROSPACE LABORATORIES
BENGALURU

Part A : TECHNICAL QUERIES & CLARIFICATION (Chapter 4)

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

Sr. No.	Query / Clarification Sought	Clarification/Amendment
1.	**Clarification Sought:** Para 4.2.1 (3) i(iii) & Para 4.3.1 (3) i(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 Discrete.	**Amendment:** Para 4.2.1 (3) i(iii) & Para 4.3.1 (3) i(iii) Deice system should have I-BIT feature. System Controller should indicate a low pressure fault within individual pneumatic circuits in the form of ARINC 429 or Discrete
2.	**Query:** 4.2.1 (3) i(v) & 4.3.1 (3) i(v) The Deice system shall accept all the signals from the control panel in their native form	**Clarification:** 4.2.1 (3) i(v) & 4.3.1 (3) i(v) The Bidder shall specify the Deice System Controller's acceptable number of signals from the aircraft control panel along with the forms. CSIR-NAL shall adapt its aircraft system to Deice system controller's input requirements.
3.	**Query:** 4.2.1 (3) i(vi) & 4.3.1 (3) i(vi) The Deice system shall provide the details on controls and signals for the proposed system components/ LRUs	**Clarification:** 4.2.1 (3) i(vi) & 4.3.1 (3) i(vi) The Deice system schematic shall provide a high level overview on controls and signals for the proposed system/LRU's
4.	**Query:** 4.2.1 (3) i (vii) and 4.3.1 (3) i (vii) All signal outputs from Deice system controller shall be compatible to ARINC 429 communication protocol.	Amendment: 4.2.1 (3) i (vii) and 4.3.1 (3) i (vii) Removed in the Amendment of tender document.
5.	**Query:** 4.2.4 (f) and 4.3.4 (f) The failure of system controller shall be provided as either Discrete or ARINC 429.	**Amendment:** 4.2.4 (f) and 4.3.4 (f) The failure of system controller shall be provided as either ARINC429 BIT or discrete output
6.	**Clarification Sought:** 4.3.4 (a) The de-ice system must be compliant with the requirements of 14 CFR Part 23 Amendment 64. The icing impingement analysis shall be performed on the Wing, Vertical Tail (VT), Horizontal Tail (HT) and of the NAL SARAS Mk II aircraft based on the icing envelopes as per icing envelopes given in Appendix C of 14 CFR Part 25. 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	**Amendment:** 4.3.4 (a) The de-ice system must be compliant with the requirements of 14 CFR Part 23 Amendment 64. The icing impingement analysis shall be performed on the Wing, Vertical Tail (VT), Horizontal Tail (HT) and Engine Air Intake Lip of the NAL SARAS Mk II aircraft based on the icing envelopes as per icing envelopes given in Appendix C of 14 CFR Part 25. 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
7.	**Clarification Sought:** 4.3.4 (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. The system shall be designed to provide for safe operation of the aircraft throughout the aircraft operating envelope	**Amendment:** 4.3.4 (b) The ice protection system – Pneumatic Deice 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. The system shall be designed to provide for safe

		operation of the aircraft throughout the aircraft operating envelope
8.	**Query/ Clarification Sought:** 4.4. (1) Components/ LRUs Technical Specification, Pressure loss characteristics (if applicable), Shelf life, TBO, Service Life, Storage Condition, Mechanical & Electrical interface envelope drawing, Pre-Installation (PI) check procedures. (Existing report(s) containing above mentioned information as it is, without making changes specific for this tender - for e.g. if technical specification and interface envelope drawings exist as a single report, is acceptable to CSIR-NAL)	**Amendment:** 4.4. (1) Components/LRUs Technical Specification, Pressure loss characteristics (if applicable), Shelf life, TBO, Service Life, Storage Condition, Mechanical & Electrical interface envelope drawing and Pre-Installation (PI) check procedures (as applicable). (Existing report(s) containing above mentioned information as it is, without making changes specific for this tender - for e.g. if technical specification and interface envelope drawings exist as a single report, is acceptable to CSIR-NAL) **Clarification:** Pre-Installation (PI) check procedures as applicable: minimum functional check procedure to be conducted on component/ LRU taken from store before installation to aircraft.

Signature of IO & PL

Annexure-II

CSIR-NATIONAL AEROSPACE LABORATORIES
BENGALURU

Part B: COMMERCIAL QUERIES & CLARIFICATION

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

Sr. No.	Query / Clarification Sought	Clarification/Amendment
1	**Query:** 4.9 Incidental Services: (i) On site Comprehensive Warranty: 2 Year from the date of acceptance	**Amendment:** 4.9 Incidental Services: (i) On site Comprehensive Warranty: 1 Year from the date of acceptance

Controller of Stores & Purchase
For and on behalf of CSIR

CSIR-NATIONAL AEROSPACE LABORATORIES
BENGALURU - 560 017

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

ANNEXURE - I

DATE & TIME: 22-Feb-2023 @ 11:00 AM

VENUE: THROUGH WEBEX & FMCD CONFERENCE HALL

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, RNCAC	Member	
4	Mr. Vineet Kumar, Chief Scientist, RNCAC	Member	
5	Mr. C.A Vinay, Principal Scientist, RNCAC	Specialist-Member	
6	Mr. Bhaskar Chakravarthy, Chief Scientist, RNCAC	Specialist-Member	
7	Mr. Lakshminarayana, Chief Scientist, RNCAC	PL, Invitee	
8	Mr. Malisetty Leela Shankar, Principal Scientist, RNCAC	IO, Member-Convenor - TSC	
9	COFA or his/her representative	Member	
10	COA or his/her representative	Member	
11	Mr Ramdas Tulshiram Pagare, SO (SP) (CoSP or his representative)	Member-Convenor (T&PC)	

NATIONAL AEROSPACE LABORATORIES
BENGALURU - 560 017

TENDER NO.: NAL/PUR/CAD/373/20-Z
DATE & TIME: 22-Feb-2023 @ 11:00 AM
VENUE: THROUGHWEBEX & FMCD CONFERENCE HALL

ANNEXURE - I

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
1	M/s. Collins Aerospace	Mr. Yugandhar Metta	NO. GLOBAL OFFLINE TENDER	yugandhar.metta@collins.com
2		Mr. Rushikesh Patil		
3		Mr. Shyam Kumar Dattatri		
4		Ms. Sudha Damodaran		
5		Mr. Samvit Kalti Gopal		

(This chapter 4 (amended) supersedes the chapter 4 provided in tender document no: NAL/PUR/CAD/373/20-Z(G) dated 6th February 2023)

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
Note: Bidder shall send Technical & Commercial Proposal for both Part A and Part B Separately.	

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 (Ice detection system and Ice protection 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.

Environmental Qualification 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 °C & max 100 °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	32 mm
c)	Max. thickness	3 mm
d)	Weight	~3 kg per sq. m
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

28/2/23

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 a low pressure fault within individual pneumatic circuits in the form of ARINC 429 or Discrete.
	(iv)	Ice detection system supplied as a part of pneumatic Deice system shall detect ice formation accurately
	(v)	The Bidder shall specify the Deice System Controller's acceptable number of signals from the aircraft control panel along with the forms. CSIR-NAL shall adapt its aircraft system to Deice system controller's input requirements
	(vi)	The Deice system schematic shall provide a high level overview on controls and signals for the proposed system/LRU's.
	(vii)	Two ARINC 429 output channels or one ARINC 429 output channel & one discreate output can be provided.
	(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. System components/LRUs shall be supplied with proper FAA-TSO'd Certificates / COC with Valid Certificate of Origin obtained from Airworthiness Authorities of the Country.

ii. System components/LRUs shall be qualified to RTCA/DO-160D or above and upto RTCA/DO-160G and the documents supporting means of compliance of qualification and endurance have to be submitted to CSIR-NAL.

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

a) Acceptance & Performance Tests

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

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	Category C4	Category C4
Temperature Variation	Section 5	Category B	Category B	Category B
Humidity	Section 6	Category C	Category B	Category B:
Operating Shock and Crash Safety	Section 7	Category B	Category B	Category B
Vibration Endurance	Section 8	Cat. S, Test Curve M	Cat. S, Test Curve L	Cat. S, Test Curve L
Explosive Proofing	Section 9	Category H, Category Zone III	Category H, Category Zone III	Category H, Category Zone III
Water-proofing	Section 10	Category Y	Category Y	Category Y
Fluids Susceptibility	Section 11	Category F	Category F	Category F
Sand and Dust	Section 12	Category D	Category D	Category D
Fungus Resistance	Section 13	Category F	Category F	Category F
Salt Spray	Section 14	Category S	Category S	Category S
Magnetic Effect	Section 15	Category A	Category C	Category C:
Power Input	Section 16	Category B:	Category B:	Category B:
Voltage Spike	Section 17	Category A:	Category A:	Category A:
Audio Frequency Conducted Susceptibility - Power Input	Section 18	Category B	Category B	NA
Induced Signal Susceptibility	Section 19	Category ZCE	Category ZCE	Category ZCE
Radio Frequency Susceptibility (Radiated and Conducted)	Section 20	Conducted Susceptibility: Category R Radiated Susceptibility: Category R	Conducted Susceptibility: Category R Radiated Susceptibility: Category R	Conducted Susceptibility: Category R Radiated Susceptibility: Category R
Emission of Radio Frequency Energy	Section 21	Category L	Category H	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:	NA	NA
Electrostatic Discharge Requirements	Section 25	Category A	Category A	NA
Fire, Flammability	Section 26	Category C	Category C	NA

28/2/23

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 amendment 23-64. Ice detectors location shall be identified by the Bidder.

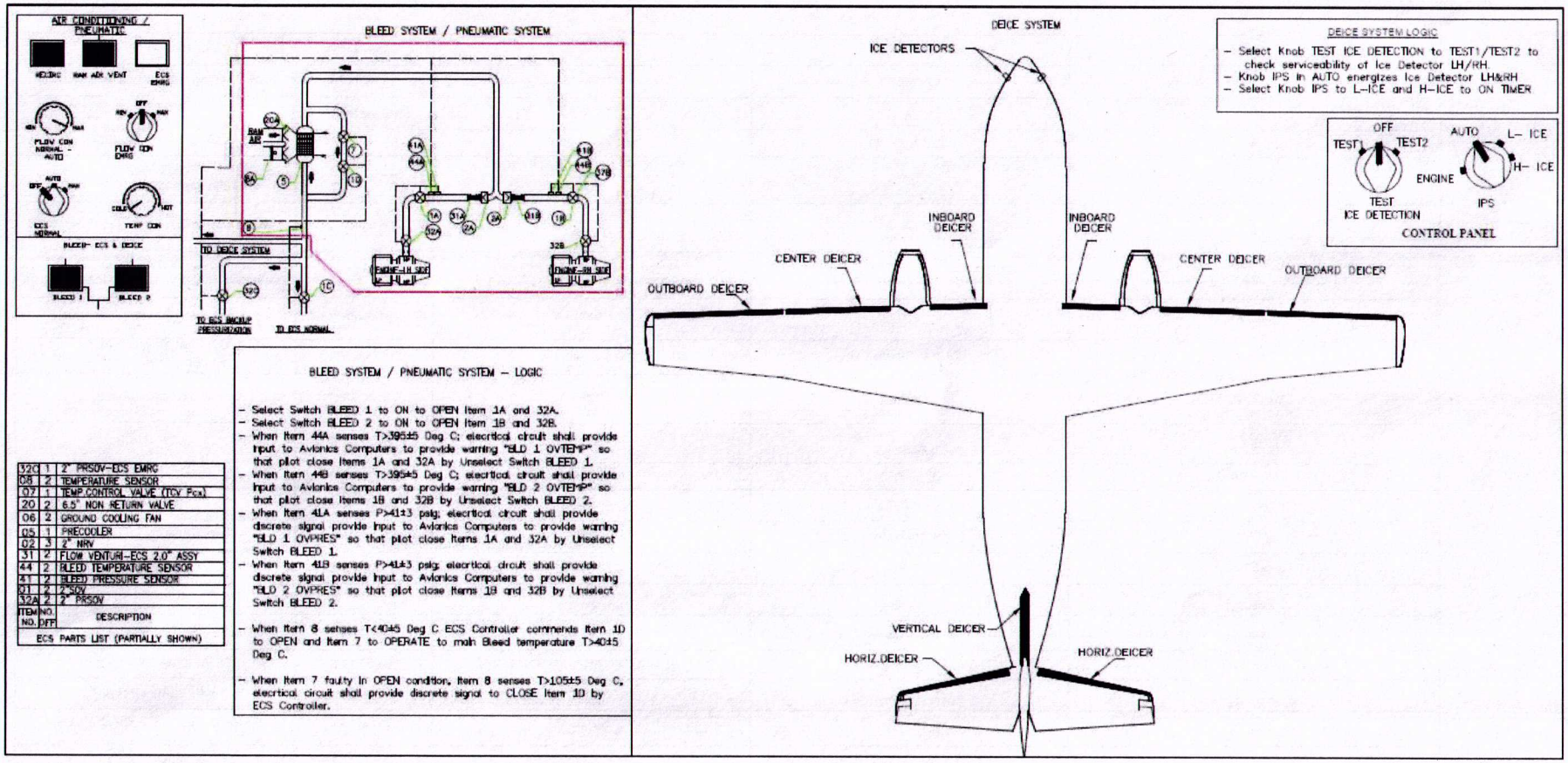

Figure 1: Saras Mk II Aircraft with Pneumatic Deicers - Leading Edges of Wing, VT and HT

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 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.

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

a) The de-ice system must be compliant with the requirements of 14 CFR Part 23 Amendment 64. The icing impingement analysis shall be performed on the Wing, Vertical Tail (VT) and Horizontal Tail (HT) of the NAL SARAS Mk II aircraft based on the icing envelopes as per icing envelopes given in Appendix C of 14 CFR Part 25. 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. 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 shall be provided as either ARINC429 BIT or discrete output

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-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.

28/2/23

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 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 components/ LRUs 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 (Ice detection system and Ice protection 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 (Ice detection system and Ice protection system) - Leading Edges of Wing, VT and HT. The individual components/ LRUs of Pneumatic Deice System to be quoted in a separate list (pdf format) which comprises the total cost of a shipset	Shipset	4

28/2/23

4.3 Detailed Specifications

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

Pneumatic Deice system (Ice detection system and Ice protection 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.

Environmental Qualification 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 °C & max 100 °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	32 mm
c)	Max. thickness	3 mm
d)	Weight	~3 kg per sq. m
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 deice system. (iii) Deice system should have I-BIT feature. System Controller should indicate a low pressure fault within individual pneumatic circuits in the form of ARINC 429 or Discrete. (iv) Ice detection system supplied as a part of pneumatic Deice system shall detect ice formation accurately (v) The Bidder shall specify the Deice System Controller's acceptable number of signals from the aircraft control panel along with the forms. CSIR-NAL shall adapt its aircraft	

	system to Deice system controller's input requirements. (vi) The Deice system schematic shall provide a high level overview on controls and signals for the proposed system/LRU's. (vii) Two ARINC 429 output channels or one ARINC 429 output channel & one discreate output can be provided. (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.
a)	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.

iii. System components/LRUs shall be supplied with proper FAA-TSO'd Certificates / COC with Valid Certificate of Origin obtained from Airworthiness Authorities of the Country.

iv. System components/LRUs shall be qualified to RTCA/DO-160D or above and upto RTCA/DO-160G and the documents supporting means of compliance of qualification and endurance have to be submitted to CSIR-NAL.

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

a) Acceptance & Performance Tests

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

28/2/23

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	Category C4	Category C4
Temperature Variation	Section 5	Category B	Category B	Category B
Humidity	Section 6	Category C	Category B	Category B:
Operating Shock and Crash Safety	Section 7	Category B	Category B	Category B
Vibration Endurance	Section 8	Cat. S, Test Curve M	Cat. S, Test Curve L	Cat. S, Test Curve L
Explosive Proofing	Section 9	Category H, Category Zone III	Category H, Category Zone III	Category H, Category Zone III
Water-proofing	Section 10	Category Y	Category Y	Category Y
Fluids Susceptibility	Section 11	Category F	Category F	Category F
Sand and Dust	Section 12	Category D	Category D	Category D
Fungus Resistance	Section 13	Category F	Category F	Category F
Salt Spray	Section 14	Category S	Category S	Category S
Magnetic Effect	Section 15	Category A	Category C	Category C:
Power Input	Section 16	Category B:	Category B:	Category B:
Voltage Spike	Section 17	Category A:	Category A:	Category A:
Audio Frequency Conducted Susceptibility - Power Input	Section 18	Category B	Category B	NA
Induced Signal Susceptibility	Section 19	Category ZCE	Category ZCE	Category ZCE
Radio Frequency Susceptibility (Radiated and Conducted)	Section 20	Conducted Susceptibility: Category R Radiated Susceptibility: Category R	Conducted Susceptibility: Category R Radiated Susceptibility: Category R	Conducted Susceptibility: Category R Radiated Susceptibility: Category R
Emission of Radio Frequency Energy	Section 21	Category L	Category H	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:	NA	NA
Electrostatic Discharge Requirements	Section 25	Category A	Category A	NA
Fire, Flammability	Section 26	Category C	Category C	NA

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 amendment 23-64. Ice detectors location shall be identified by the Bidder.

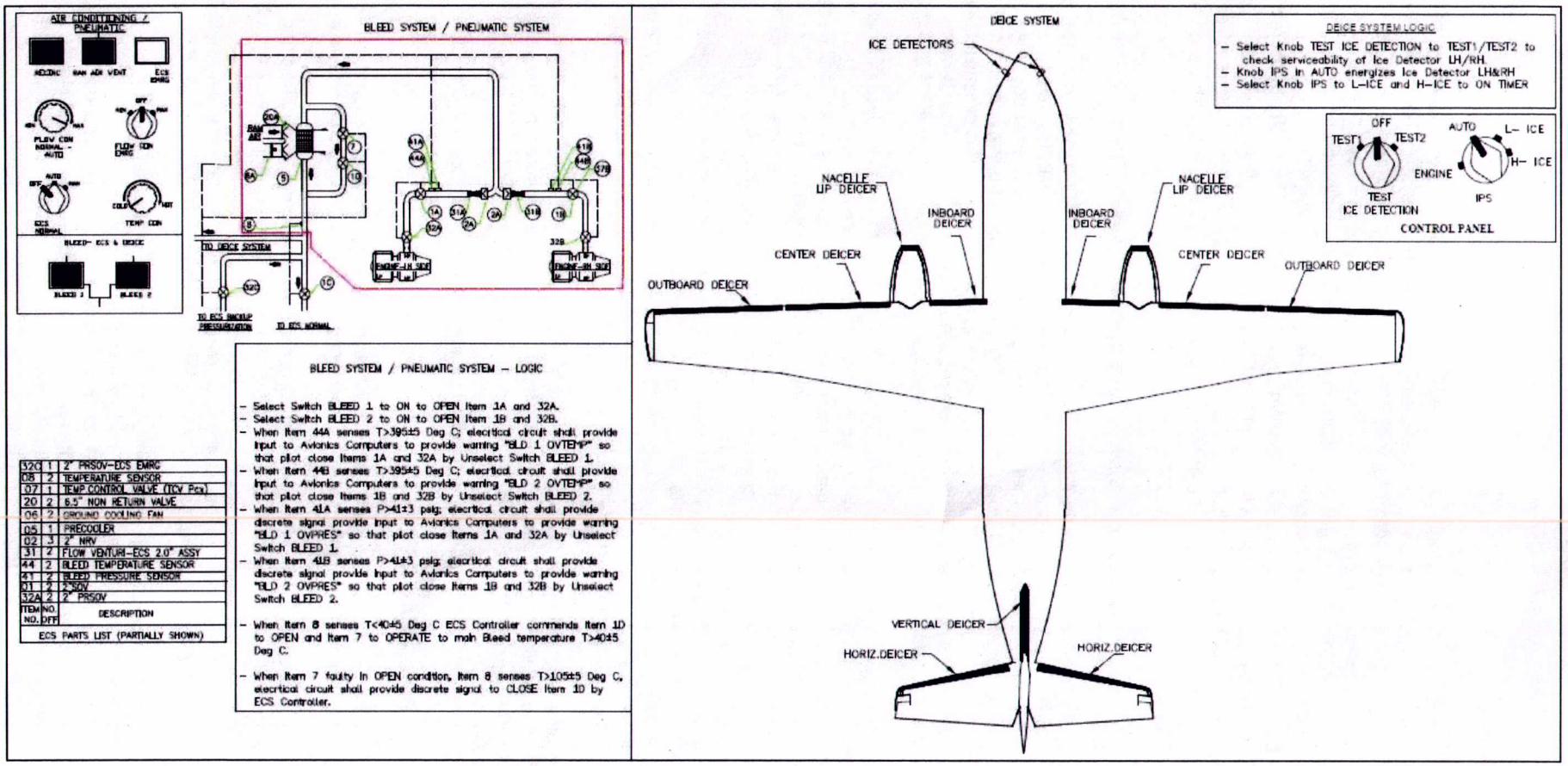

Figure 1: Saras Mk II Aircraft with Pneumatic Deicers - Leading Edges of Wing, VT, HT and Engine Air Intake Lip

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 de-ice system must be compliant with the requirements of 14 CFR Part 23 Amendment 64. The icing impingement analysis shall be performed on the Wing, Vertical Tail (VT), Horizontal Tail (HT) and Engine Air Intake Lip of the NAL SARAS Mk II aircraft based on the icing envelopes as per icing envelopes given in Appendix C of 14 CFR Part 25. 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 and 4.3.4.4.

b) The ice protection system – Pneumatic Deice 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. 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 shall be provided as either ARINC429 BIT or discrete output.

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:

2 Station references and rib locations.

3 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.

4 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.

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

6 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.

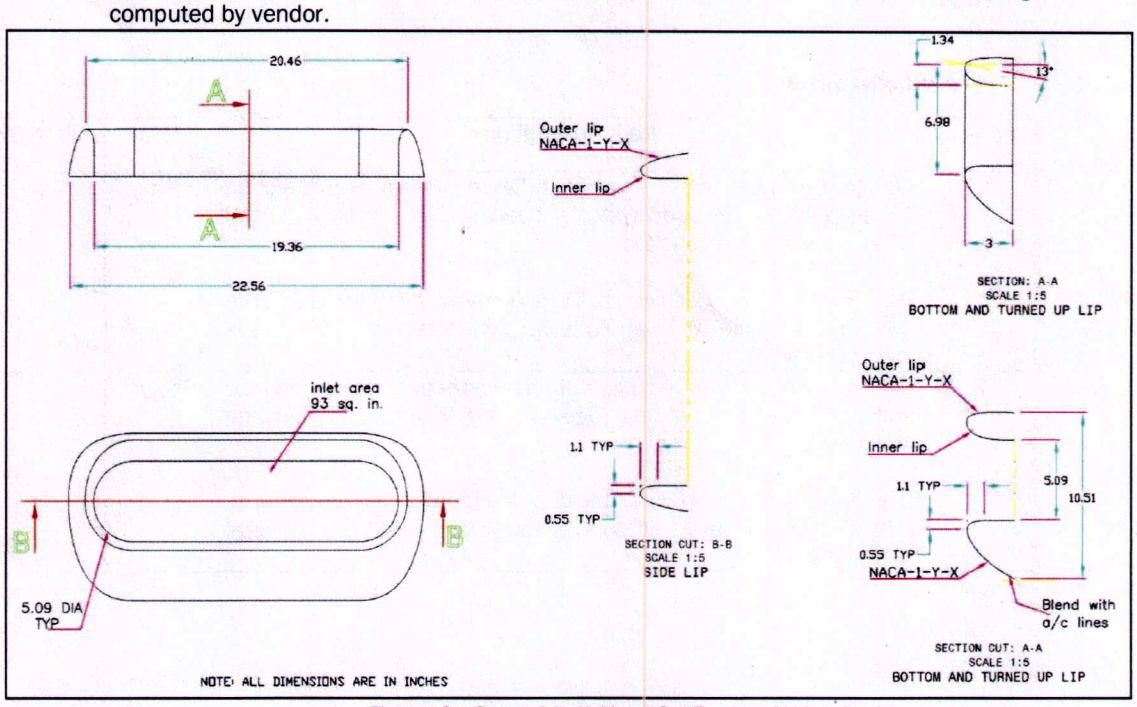

Figure 2: Saras Mk II Aircraft - Engine Air Intake Lip

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 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 components/ LRUs 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 (Ice detection system and Ice protection system) - Leading Edges of Wing, VT and 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 (Ice detection system and Ice protection system) - Leading Edges of Wing, VT and HT and Engine Air Intake Lip The individual components/ LRUs of Pneumatic Deice System to be quoted in a separate list (pdf format) which comprises the total cost of a shipset	Shipset	4

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.	Components/LRUs Technical Specification, Pressure loss characteristics (if applicable), Shelf life, TBO, Service Life, Storage Condition, Mechanical & Electrical interface envelope drawing and Pre-Installation (PI) check procedures (as applicable). (Existing report(s) containing above mentioned information as it is, without making changes specific for this tender - for e.g. if technical specification and interface envelope drawings exist as a single report, is acceptable to CSIR-NAL)
2.	Applicable steady state and transient performance characteristics of all LRUs/ Items
3.	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.
4.	Declaration of Design and Performance (DDP)
5.	Functional Hazard Analysis (FHA)
6.	Failure Mode Effects Analysis (FMEA)
7.	Qualification test procedures (QTP)
8.	Qualification test report (QTR)
9.	Acceptance test procedure (ATP)
10.	Acceptance test reports (ATR)
11.	COC/ FAA Form /EASA Form One or Equivalent

4.5 **Services**

(i) Preliminary design review (PDR) and the Critical design review (CDR) to be held at Bangalore by Bidder.

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

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.

28/2/23

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. 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).
5. Supply of Sub systems/ LRUs of Pneumatic Deice system and Support for Service of LRUs on need basis.

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.

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 Acceptance Test

The acceptance tests will be conducted by the Purchaser at Purchaser's site. The acceptance will involve trouble free operation. No malfunction, partial or complete failure of any part of the equipment is expected to occur.

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) Functional Check

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.

4.9 Incidental Services

(i) On site Comprehensive Warranty:

- 1 Year from the date of acceptance.
- In case the Equipment / System remains non-operational due to defect arised in equipment 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 & Acceptance)

Delivery of the Item			Acceptance of the item
Days/ Weeks/Months		Location	Days/ Weeks/Months from the date of receipt of item
Supply of documentation for Pneumatic Deice System (Ice detection system and Ice protection system), mentioned in para 4.4 sl.no: 1, 5, 6 and 9.	by 3 months from PO	CSIR-NAL, Bangalore	1 Month
Supply of documentation for Pneumatic Deice System (Ice detection system and Ice protection system), mentioned in para 4.4 sl.no: 2, 3, 4 and 7.	by 6 months from PO		
Supply of 4 sets of Pneumatic Deice System components/LRUs (Ice detection system and Ice protection system) along with documentation mentioned in para 4.4 sl.no: 8, 10 and 11	by 18 months from PO		