



The SAGA of SARAS : Part - II

Report on Significant Events/Milestones Reached During the Making of SARAS Prototype - II and the Lessons we Learnt from PT - I

Period of Event Reporting : October 2006 to April 2007

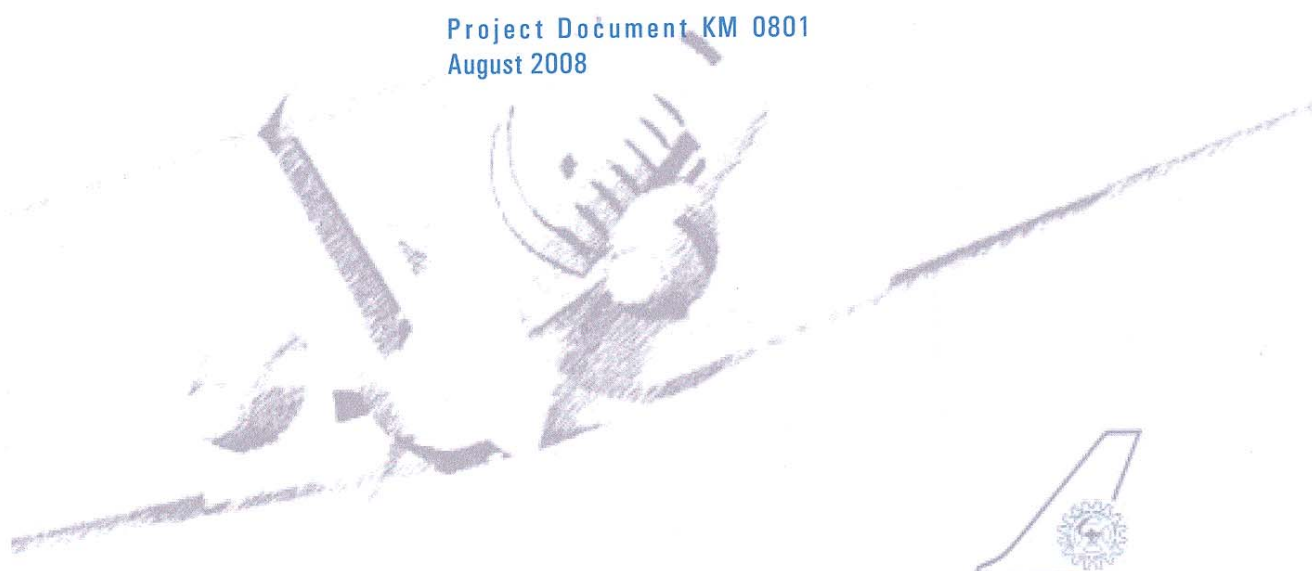
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**Project Document KM 0801
August 2008**



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The SAGA of SARAS: Part-II

*Report on Significant Events / Milestones
Reached During the Making of
SARAS Prototype - II
and the Lessons Learnt from PT - I*

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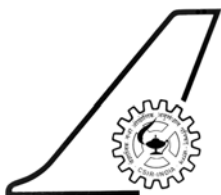
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**National Aerospace Laboratories
Bangalore**

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THE SAGA OF SARAS: Part – II

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Report on Significant Events / Milestones Reached During the Building of SARAS Prototype – II and the Lessons Learnt from PT- I

1. **Abstract:**

This NAL Project Document highlights pioneering efforts made by the Centre for Civil Aircraft Design and Development in building the SARAS Prototype – II. SARAS Prototype – II, NAL's 14-seater light transport aircraft had its successful maiden flight on 18 April 2007 at 09:05 a.m. Several improvements have been incorporated in SARAS PT-II compared to the first prototype. Most important among these are the installation of higher power engines P&WC 6A-67A of 1200 hp each and new propellers of larger diameter. The supporting stubwing structure and the engine nacelle have also been modified to suit the new engines. Added to this, significant improvements have been incorporated in the layout of flight control system, avionics and electrical systems. These improvements have brought PT-II much closer to the final production standard aircraft.

2. **Introduction:**

The SAGA of SARAS: Part – I was published in October 2004 as an NAL in-house Project Document (PD IM 0407). This document highlighted the significant milestones achieved in the SARAS Prototype – I programme. This programme was very unique in the sense that it was the first indigenous effort to design and build a 14 seater multi-role light transport commuter aircraft.

The exercise of reporting on the SARAS events (Prototype – I) commenced around June 2003 when the SARAS programme was catching up momentum and the articles were regularly posted on the NAL Home Page (www.nal.res.in). This was finally composed into a comprehensive NAL document entitled-“The SAGA of SARAS: Part – I (PD IM 0407)” and is now available (in .pdf format) on the NAL web site under the sub-heading: NAL's Publications.

The event reporting covered various milestones that the programme went through prior to its first flight which took place on 29 May 2004. Prior to the first

flight, SARAS had a very colourful roll-out on 4 February 2003, when for the first time the 'big bird' emerged from the hangar.

The first formal inaugural flight of SARAS took place on 22 August 2004. The function was given wide publicity in the media. Hon'ble Minister of State for Science and Technology, Shri Kapil Sibal graced the occasion and amidst a large gathering. SARAS PT-I soared into the clear blue sky on 22 August 2004.

A new chapter was written in the history of Indian Civil Aviation; Team SARAS had proved to the nation that given an opportunity, 'nothing is impossible to achieve'.

Scorching heat at the Aircraft Systems and Testing Establishment (ASTE) tarmac, the mid-afternoon blistering sun on the airport runway, the cold winter mornings atop the ASTE telemetry tower with winds blowing over 10 knots became a part of a regular routine in covering the various milestones of the SARAS programme.

Apart from the event reporting on SARAS milestones, the KTMD multimedia group also had the additional responsibility of supporting the SARAS flight test activities by providing real-time digital videography at the ASTE telemetry tower to aid the Flight Test Director in observing vital parameters of the aircraft in 'real-time'. Real-time digital videography plays an extremely important role during the SARAS taxi trials and flight operations. Especially, during critical phases like take off and landing, availability of real-time video gives a better appreciation of the aircraft attitude, pitch angle, flare, etc. to the Flight Test Director.

This involved positioning of video cameras in vantage positions on the ASTE telemetry tower, north side of the ASTE and on runway 27 end or 09 end, depending upon the wind direction on each day.

SARAS PT-I was truly a synergy of multiple efforts. Major players emerged as synergizing partners like TAAL, CMERI, SERC, CECRI, ADES, HAL, ADA, ASTE, GTRE and more than 25 small and medium scale industries. Towards the successful first experimental flight of SARAS PT-I, approximately 4000 detail tools, 30 assembly jigs, about 15 ICY gauges and a total number of 20,000 SARAS parts were designed and manufactured for the SARAS work. Such was the magnitude of this programme.

3. *The Making of SARAS PT-II: The Hard Lessons learnt from PT-I*

Mr M S Chidananda, Programme Director opines that 'there were quite a few lessons to be learnt from the experience gained on SARAS Prototype – I. The following are the most significant ones that very easily come to my mind:'

- While assembling and integrating the PT-I, it was a maiden experience for those involved in the structural assembly, avionics and other systems integration, equipping the aircraft etc.. Many bracketries and other related structural elements needed for system integration had to be made and 'suited on assembly'. This was handled in a much better way on PT-II by prior planning. Avionics system integration and testing on PT-II took nearly half the time as compared to PT-I.
- The integration of Flight Control Systems, fuel, hydraulics and power plant also was completed within about three months. Aircraft level tests were also completed quickly and approved by DGCA officials who were by now quite familiar with the SARAS features.
- TEAM SARAS also took up the initiative, perhaps for the first time, in the country, to carry out endurance testing of the PT-II propeller, as per FAR-33/JAR-33 requirements. This required a total testing of the engine-propeller combination for 200 hours, on an engine test bed at NAL. This was a new experience to NAL and the work was carried out successfully.
- The power plant installation (including propeller) also was completed in about two week's time with attendant system checks. The propeller design was modified to facilitate quick assembly / disassembly of individual blades, once the hub was assembled as a unit. This feature resulted in quick change of individual blades.
- Oil cooler location on PT-II was modified and brought forward to achieve better cooling in flight. An ejector was used to cool the oil during ground operations and taxiing. These major changes were brought about by minimal ground tests, mainly due to lessons learnt from the experience on PT-I. Oil temperatures on ground and in flight were far better compared to PT-I.
- Overall, there was greater confidence on the part of all those involved, the designers, engineers on the shop floor, the DGCA officials, the flight crew and the ground crew while getting the PT-II ready for flight'.

To realize the goal of the first flight of SARAS PT-II, the entire SARAS project team had been working day and night with hardly any break to make the aircraft ready for the first flight. Talking to Dr K Yegnanarayan and Mr M S Chidananda, (PGD and the PD of the SARAS programme), I learnt that the 'actual countdown' for the first flight of PT-II started on 23 March 2007 itself when the first low speed taxi trial commenced after obtaining clearances from FRRB (Flight Readiness and Review Board) and the DGCA (Director General of Civil Aviation). They added that, prior to this, about 16 engine ground runs had been carried out by the flight crew at NAL/ASTE. In all, 11 taxi trials were conducted before the first flight. These consisted of 4 low speed, 4 high speed and finally 3 SOP taxi trials.

After two full fledged detailed meetings, both the FRRB and DGCA gave the go ahead for the first flight of PT-II on 17 April 2007. SARAS PT-II inaugural flight took place on 18 April 2007 amidst the NAL family members and a selected gathering of dignitaries from the various sister aerospace organizations.

4. SARAS-PT-II Makes Its Maiden Flight

SARAS PT-II had its successful maiden flight on 18 April 2007 at 09:05 hours. Wg. Cdr. R S Makker (the chief test pilot of SARAS PT-II), was ably assisted by his team members, comprising of Wg. Cdr. A Malik as the co-pilot and Wg. Cdr. M S Ramamohan as the flight test engineer, all belonging to the Aircraft Systems and Testing Establishment (ASTE) of the Indian Air Force. The aircraft take off distance was about 2700 ft., the unstick speed was around 118 knots, the initial climb was pretty steep. The rate of climb was in the range of 1700/1800 ft/min. with the undercarriage extended. The chase Kiran had initial difficulty in keeping pace with this rate of climb at 130 knots with SARAS. In the first flight, SARAS reached a max. altitude of 9200 feet. It flew for about 45 minutes and the max. speed attained was 150 knots. Wg. Cdr. R S Makker during his brief interview with the NAL camera crew after the touchdown was quick in saying that "SARAS flew like a PEGASUS - absolutely wonderful".

The touch down of SARAS PT-II around 09:50 a.m. on 18/04/2007 witnessed an elite gathering. This included Dr A R Upadhyaya, Director, NAL; Air Cmde. M Matheswaran, VM, Commandant, ASTE; Air Marshal P Rajkumar (Retd.); Chairman, FRRB; Prof. R Narasimha, Dr T S Prahlad and Dr B R Pai (former Directors of NAL); DGCA officials and senior NAL staff members. Apart from this, the entire TEAM SARAS was present. The flight test was directed by Wg. Cdr. P Ashoka (retd.).

The flight crew and the aircraft readiness and ground crew were warmly applauded after the successful touchdown of SARAS at the ASTE Tarmac around 09:50 a.m. The mood was jubilant. All of a sudden, out of nowhere bottles of champagne popped indicating another glorious triumph in the history of civil aviation in the country. Warm hugs, messages of congratulations and 'Hip Hip Hooray' shouts filled the atmosphere. The thundering take-off and landing of MiGs belonging to the ASTE wing of IAF were drowned by the *euphoria that SARAS touch down generated*.

This was definitely a feather in NAL's cap after having embarked on this most ambitious civil aircraft development programme.

Several improvements have been made in SARAS design from PT-I to PT-II. The most important among these is the switch over to higher power engines PT 6A-67A of 1200 hp each in PT-II in place of PT6A-66 of 850 hp each used in PT-I and new propellers of larger diameter. This was done to meet the stringent climb gradient requirements, in the event of one engine failure, as stipulated by

Federal Aviation Regulations-25 (FAR-25) of USA, the certification standard for SARAS. These higher powered engines will definitely improve the other performance characteristics of SARAS. The supporting stubwing structure and the engine nacelle were also modified to suit the new engine. Improvements have also been incorporated in the flight control layout, flap operating system, avionics, electrical system layout etc.. taking into account the inputs received from the flight crew and maintenance staff. All these significant improvements have brought PT-II much closer to the final production standard aircraft.

'Parallely, a weight optimization programme has also been taken up for SARAS, with a target of 500 kg weight reduction, through optimisation of metallic structures, stringent fabrication control, increased use of composites etc. An additional prototype PT-III will now be built to the final production standard and proved through a combination of ground and flight tests. The programme group has targeted end 2009 to attain the FAR-25 standard certification by the Director General of Civil Aviation according to *K Yegna Narayan and M S Chidananda*'.

Several discussions are on with the Indian Air Force who most probably would be the launch customers for SARAS for meeting some of their transport and training requirements and also with HAL for productionising the aircraft. By gradually increasing the all-up weight of 7100 kg, the performance of the PT-II aircraft would be demonstrated to the IAF.

In this connection, the maiden flight of SARAS PT-II is a very significant milestone in the history of Indian Civil Aviation in India which would ultimately pave way for establishing a viable civil aircraft industry in the country.

5. *'Beauties Overcome the Beasts': SARAS PT-I Dazzles at Aero India 2007.*

One of the most significant achievements of the SARAS programme was the flypast and flying demonstration of SARAS at the Aero India 2007. SARAS became the only prototype aircraft that participated in both the static and dynamic display as well as flying demonstrations that were held during 7-11 February 2007.

Wg. Cdr. R S Makker, the chief test pilot of the SARAS programme in his article- "SARAS has completed 100 flights flamboyantly", mentions that SARAS achieved this important milestone of participating in both static and dynamic displays at Aero India 2007 with just about 65 hours of flight testing. This remarkably proved the maturity of its design and robustness.

During the flying displays many of our own colleagues could not spot SARAS at first sight as it had a totally different look. The aircraft had 'streaks' of vibrant colours depicting the mood of the year 2007 ('India Poised Year: 2007': <http://timesofindia.indiatimes.com/articleshow/1002923.cms>). The final chosen

design pattern which adorned SARAS depicted a bird in flight combined with the national tri-colour scheme.

Wg. Cdr. Makker said, “the demonstration of SARAS in Aero India 2007 began with rigorous preparations comprising of exhaustive planning of manoeuvres for the flying demonstration, accurate route navigation for the flypast, thorough briefings, critical post pilot debriefs and a quick look at the post flight data analysis. All these activities were spread over several practice sorties flown over Bangalore and Yelahanka airfields. Every sortie was a step towards achieving the ‘immaculate flying demonstration of SARAS’ by the ASTE flight crew”.

SARAS's perfect flying demonstration during Aero India 2007 won appreciation from all quarters alike and carried a detailed press-report the next day.

SARAS was piloted by Wg. Cdr. R S Makker, the chief test pilot of ASTE and his crew. Speaking to him, I learnt that SARAS had sorties on all the days of the show. However, on the first day it made three sorties. To keep the audience enthralled it flew as low as 500 ft and with noticeable ‘banking’ angles being about 60-65°. Most importantly, to the delight of every Indian completed its 100th test flight during the course of this air show.

6. *The Digital Content Spin-Offs of the SARAS Programme*

Covering the important SARAS PT-II milestones on the NAL Home Page and the continued support to aid the flight test director in real-time, digital videography by KTMD had its significant digital spin-offs. As on date, KTMD has lent support to the SARAS programme for 123 PT-I and 10 PT-II flights.

The digital spin-offs of covering the PT-II milestones generated close to 385.332 MB of digital photo archives. Most of the information has been hosted on the NAL Web Site. An important aspect of PT-II event reporting was the introduction of ‘SARAS Collages’ on the NAL Website highlighting the milestones. Since the digital photographs are available on the Home Page, with a fairly good resolution, these aided the various SARAS groups in picking up the required photos from the Home Page for use in various technical presentations on SARAS. Some of the digitally archived photographs on PT-II were used in generating NAL posters, material for annual report and in generating various in-house brochures on SARAS. Eventually, these photographs and digital video archives will form an integral part of the ‘Digital Multimedia (Image and Photo) Repository’ that NAL wishes to embark soon to preserve its ‘Glorious Scientific Heritage’.

7. *Acknowledgements*

The authors thank Dr A R Upadhyaya, Director, NAL for encouraging us to cover these significant milestones of SARAS and reporting them regularly on the NAL Information PasteBoard under the SARAS-Countdown Columns.

The co-authors are immensely grateful to Dr Ranjan Moodithaya, Head, Knowledge and Technology Management Division for encouraging and permitting us to contribute to the SARAS countdown columns. His timely editing and fine-tuning of the articles for making it web-ready has enabled the SARAS milestones to be hosted on the NAL Home Page always on time.

Dr K Yegna Narayan and Mr M S Chidananda, in their capacities as PGD, Civil Aviation Programme and PD, SARAS always spared their invaluable time and helped us in providing the crucial inputs. Similarly, the other team members of the SARAS programme helped us in giving their technical inputs.

The authors immensely thank TEAM SARAS (specifically the hangar staff) who always cooperated with us whenever videos or digital footages needed to be taken.

The SARAS flight test crew headed by Wg. Cdr. R S Makker and his co-test-pilots were always available at ASTE to share their rich experiences of the behaviour of SARAS PT-II during all taxi and flight tests. Inputs from Wg. Cdr. P Asoka (retd.) as the flight test director were extremely useful whenever we had to cover the telemetry operations.

The authors also thank all the HODs involved in the SARAS programme for spontaneously discussing SARAS activities concerning their respective contributions to the SARAS programme.

Thanks to our colleagues Mr D Freddy and his photography team who assisted in providing video footages of SARAS PT-II lift-off from the HAL apron side. We in fact, would like to make a special reference to this particular video clip, which was shot by (Late) Mr. Badrinath of the Photography Unit. A thorough gentleman who in spite of his grave illness always put duty ahead of personal work. Mr Badrinath passed away on 14 May 2007 when the SARAS activities were at peak. One of the embedded video frames on the 2 ½ minute video clip on SARAS PT-II's First Inaugural Flight (which has been hosted on the NAL site) is our fond tribute to our beloved colleague (Late) Badrinath.

Digital photography of the SARAS milestones were jointly shot by the author and ably assisted by Mr R Kumar, Cameraman (ADES Contract) and now attached to KTMD. Mr Kumar played a significant role in covering many of the significant events, apart from his responsibilities in handling the real-time video coverage of SARAS flight activities.

Some of the collages that are hosted on the NAL web-site under the SARAS countdown column were prepared by Mr J Kumaravelu (contract staff, KTMD multimedia group).

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The authors would also like to thank our KTMD colleagues Mrs Shailaja Menon for posting the SARAS events on the NAL Home Page and Mr A S Rajasekar for DTP composition of the articles on the NAL Information PasteBoard.

Dr Vidyadhar Y Mudkavi, Head, CTFD greatly helped us in archiving the event coverages on the computer workstations at CTFD. This greatly helped as a mid-point in storing SARAS digital images for easy access to both the Belur and Kodihalli campuses. He also extended his help in providing CD/DVD media to archive the milestones chronologically. This was very useful to us during all event coverages.

Last, but not the least, the authors wish to dedicate the two volumes of SAGA of SARAS: Part-I (which appeared in October 2004), and now presently hosted on the NAL Home Page (www.nal.res.in) and the SAGA of SARAS: Part-II (ready for print and soon to be hosted on the NAL Web Site) to those great visionaries who thought of a 'viable civil aviation industry for India', namely, (Late) Prof. Satish Dhawan, former Chairman of the Space Commission and (Late) Sri Raj Mahindra, Consultant, C-CADD.

Hence, it was most appropriate by the NAL management to register the two prototypes of SARAS, namely SARAS PT-I as VT-XSD and PT-II as VT-XRM, in honour of these great visionaries.

Finally, this document in a way is a tribute by the authors to Prof. R Narasimha, Dr T S Prahlad, Dr K N Raju and Dr B R Pai (former Directors of NAL) and Dr A R Upadhyaya (Director, NAL) without whose dynamic, persistent and persevering leadership, the rich blue Indian skies would not have witnessed the 'grace and poise' of SARAS PT-I and PT-II flying. That too, with streaks of Indian tricolour prominently displayed.

The Authors.....

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SARAS Countdown column on www.nal.res.in

Integration and Equipping Activities

#IP 736 23-29Oct 2006

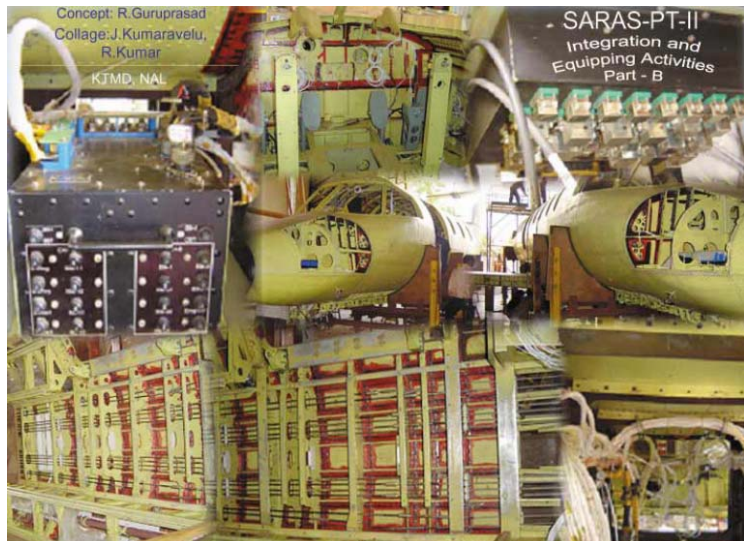
A Summary of events that took place between June to September 2006.

There has been significant progress on the SARAS PT-II developmental activities at the SARAS hangar.

The SARAS fuselage majestically occupies the centre-stage of the hangar, waiting impatiently to roll out in a couple of months to join the senior partner PT-I which has successfully logged 70 flights.

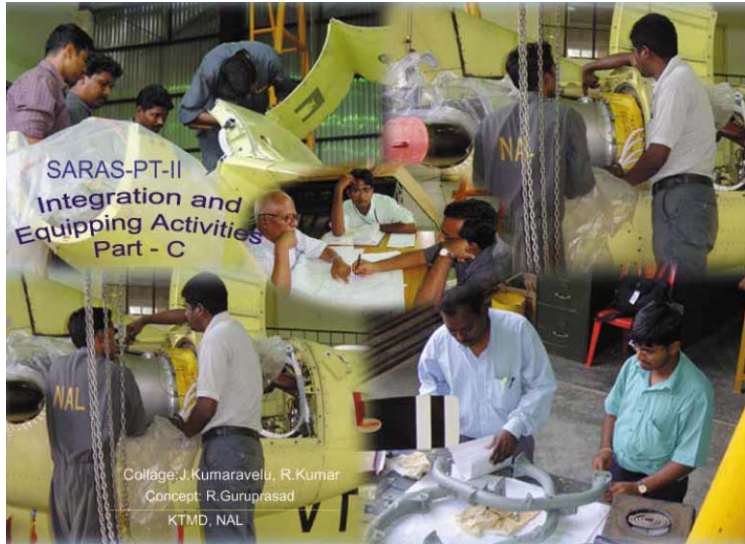


The wings have been mounted on the aircraft and the fuel system components are in place. Electrical cabling and looming activities are on to meet the stringent deadlines. The elevators, rudders and the landing gears are in place. Line replacement unit (LRUs') of fuel system, hydraulics and electrical system are



being installed in the belly fairing. Environmental control systems (ECS) pack installation in the aft fuselage is on. Another group is working meticulously on the electrical and avionics system.

At an adjacent corner, the RH and LH nacelle assembly is in full progress. Mounting the SARAS PT-II engines inside the nacelle is going to be a very involved affair in the days to come as the related systems like the ECS bleed system, fuel supply lines, fire sensing and extinguishing and the electrical lines are also resident inside the nacelle.



At the HANSA hangar, M/s CADES is supporting the SARAS activity with their involvement in the stub wing assembly along with the assistance of our own technicians and supervisors. Stub wings are structures mounted at the aft end of the fuselage bridging the engine mount to the fuselage. The entire load generated from the engine mount is transferred to the fuselage structure through the stub wings.

On 7 September 2006 the horizontal tail mounting activity took place. The horizontal tail is a very important structural module of the aircraft, which imparts the horizontal stability to the aircraft. The elevator is a primary control surface, mounted on the horizontal stabilizer which controls the pitch of the aircraft (up & down movements). The horizontal stabilizer is attached to the aircraft through the vertical tail by means of a fork & eye end attachment. All the critical fittings on the horizontal tail are fitted with the 12mm dia high strength bolts. The safety of the joint is ensured by a self-locking nut & use of split pins.

Progress on flight control systems (FCS) equipping is another important activity worth mentioning. The FCS equipping in cockpit is almost complete and all the installation pertaining to the brackets, quadrants and levers below the cockpit floor are completed. Very soon we are going to witness another milestone of SARAS PT-II to take off to the skies.

R Guruprasad with Suju Thomas



Horizontal Tail and Stub Wing Mounting Activity

#IP 737 30 Oct - 5 Nov 2006

The SARAS horizontal tail assembly consists of the metallic horizontal stabilizer and the composite control surface 'elevator'. This is a very important structural module of the aircraft, which imparts the horizontal stability to the aircraft. The elevator is a primary control surface, which controls the pitch of the aircraft. The horizontal stabilizer is attached to the aircraft through the vertical tail by means of a fork and eye end attachment. The horizontal stabilizer has two fork type fittings attached to front and rear spars which engages into eye end fittings attached to rear and middle spars on the vertical tail through four 12mm dia high strength bolts. The safety of the joint is ensured by a self-locking nut and use of split pins. The location of the attachment fittings is strictly controlled in the jig during their assembly by use of ICY gauges. This ensures the proper matching of the fittings during integration.



The LH and RH elevators are attached to the horizontal stabilizer at two hinges (I/B and O/B) located in the aft box of the horizontal stabilizer by means of bolts and are also connected at the centre by a common torque shaft which ensures symmetry of movement of both the elevators

The stub wing assembly is mounted at the aft fuselage at STA #29A and at STA #32 bulkheads. The attachment is by means of four 25mm dia high strength steel bolts. The fuselage side has an eye end fitting housing 25mm dia bearings and the stub wing side has a fork end, which is an integral part of the front and rear spars pressed with 25mm ID steel bushes. A small installation gap is provided between the eye and the fork fitting at the rear attachment. These are filled by a thrust washer and split spacer. This is to safeguard the bolts from very high shear loads.



The stub wings are loaded on the A-frame using belt rope and is maneuvered skillfully to align the fork end and with the fuselage eye end and bolts are engaged carefully and locked one after the other. The stub wing has a dihedral of 28 deg with respect to the fuselage, which is maintained through the design of the stub wing spars. This is measured after installation by use of dihedral boards.

The yoke assembly on which the engines of the aircraft are mounted is fitted to the stub wing yoke bracket by two 17mm dia high strength steel bolts. A common drill jig has been provided to ream the attachment holes of the yoke and the stub wing yoke bracket to ensure the matching of the attachment on aircraft. The reaming of these holes has to be done with a high degree of precision since these parts are subject to very high loads and vibration during the operation of the aircraft.



As I leave the SARAS Hangar admiring the aircraft, I am only remembered of this line of John Keats that 'a thing of beauty is a joy for ever' - (Endymion (1818)). And, how remarkably, SARAS symbolizes this.



R Guruprasad with Suju Thomas

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Nacelle and Engine Integration **#IP 738 6 - 12 Nov 2006**

At the SARAS hangar, this week's activity is centered around the nacelle and engine installation on the aircraft.

The nacelle on the aircraft is attached to the stub wing through the L & M inboard frames. An integral part of the stub wing. Inboard L frame is attached to the root rib at #3, front spar, skins and tie rod brackets by 5mm diameter bolts and nuts. Inboard M frame is attached to End Rib at #3, machined spacers and the skins by 5mm diameter bolts and nuts. The L & M inboard frames are attached to the O/B and bottom L & M frames of the nacelle through the longerons and splice boxes by 5mm diameter bolts and anchor nuts.



The SARAS PT-II is now powered by two 'PT6-67A' engines. These are attached to the engine mount yoke I/B & O/B through shock mounts mounted on engine mounting pads. The shock mounts are attached to the yoke cup brackets by bolts and self locking nuts. The engine is also attached to the stub wing tie rod bracket by tie rods attached to the top and bottom ends of the inboard yoke. Engine installation is definitely a delicate process involving deft maneuvering. It is first maneuvered in position to the inboard yoke and then the outboard yoke is locked to the inboard yoke with 10mm diameter bolts and nuts at the top and bottom flanges. In its installed condition, it has a pitch up of 2 deg and a toe-in of 1.5 deg with respect to the aircraft axis.

On the integration and equipping side, it is seen that the assembly of the windshields-front and side and the assembly of the pax cabin windows have been completed. Fitment of antennas atop the top skin of the fuselage are completed. Swaging and load testing of all the FCS cables have been completed and have been taken up for final installation. Installation of distribution box1 in cockpit has been completed.

R Guruprasad with Suju Thomas



"Country Road-Take Me Home..." **#IP 739 13-19 Nov. 2006**

"Almost heaven.. .Blue Ridge Mountains.. .Shenandoah River..." . I would have loved this backdrop to reach the SARAS hangar. Mother nature has something else in store;

the Challaghatta Stench and the Spine-Breaking 'Country Road'.

As I reach the hangar overcoming nature's hurdles, I notice that the looming activity is progressing rapidly and the routing to the forward bay has been completed through the LH side of the belly chute. The belly chute doors have been fixed with the hinges &



camlocs. The installation of the hydraulic LRUs in the RH belly fairing have been completed. Swaging of all the pipelines has been completed and pressure tested. The air data boom tube has been fixed on the aircraft with the assistance of the metrology staff and assembled. The MLG door assemblies have been completed on both the LH and RH side.

As I begin packing my digital camera, another arduous drive awaits me - "Country Road. . . take me home... to the place I belong".

R Guruprasad with Suju Thomas

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'These Are A Few Of Our Favourite Things'

#IP 740 20-26 Nov 2006

'Aprons of Blue, nerves of steel, dreams of victory and joys of fulfillment. These are a few of our favourite things'.

Amidst this boisterous group of *Team SARAS*, I notice that there have been rapid strides made in the SARAS activity this week. The equipping activities this week centered around the engine equipping where the ejector system, SG exhaust, fuel & torque sensor system have been finalised. All cockpit looms have been positioned. The belly fairing LRU access covers have been completed.

The path ahead looks herculean, but these 'brave men' will take us to the summit.

It is well past 7 pm when I leave the hangar. The fast approaching 'silent night' will seamlessly transform into the wee hours of the morning. The 'clanking' and 'riveting' will not stop, but will continue to ring in your ears. In a few minutes from now, the baton will change *hand* to ensure that '*Team SARAS*' will not come to a *stand*.

R Guruprasad with Suju Thomas





'Its Time For An ECG' **#IP 741 26 Nov - 3 Dec 2006**

At the hangar I observe that SARAS looks completely closed up and cordoned off with metal and rope strings. The aircraft is completely strapped up with wires running all around reminding of those 12 self-adhesive probes from a typical ECG apparatus, as if the aircraft is put on a rigorous ECG test.



If ECGs aid in measuring the electrical activities of the human heart, my colleagues at the Structures Division tell me that GVTs (Ground Vibration Tests) are an absolutely mandatory exercise to be carried out on a newly developed aircraft to assess its dynamic characteristics before its first flight. This is more so because of the number of interesting modifications that SARAS PT-II has undergone in its engine type, stub wings, yoke, propellers, nacelle and finally the relocation of the line replaceable units (LRUs).

Dr S Viswanath, tells me that 'our study is mainly focussed on how these modifications that have been integrated onto PT-II could in any way interfere with the dynamics of the aircraft. The results of the GVT would now be used to tune the mathematical (FEM) model of the aircraft to enable flutter prediction before the first flight of PT-II'.

It's clear to me that the GVTs are a long drawn procedure. The aircraft is instrumented with about 120 accelerometers for studying critical responses. Four electrodynamic shakers provide the necessary excitation to the aircraft. A 64 channel SCADA-III system with CADAX software is used to give force input, acquire and analyze the data in MIMO mode. Typically, the aircraft is tested in two non-identical conditions (full fuel and zero fuel).

The GVTs are on from 26 November 2006. 'The initial data generated indicates no major worries says Dr Viswanath'. However, detailed analysis and FEM correlation needs to be carried out soon to arrive at our flutter margins.

Our colleagues at the Structures Division richly deserve our warm accolades for a job wonderfully completed, within a record time of four days.

I leave the hangar with a happy and optimistic note that the 'big-bird' is maintaining a 'healthy condition' and a perfect 'heart rhythm'.

R Guruprasad with Suju Thomas

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Significant Progress on Electrical Looming

#IP 742 4 - 10 Dec 2006

A thorough planning of the electrical system is absolutely essential in an aircraft development programme. You will need to route the electrical wiring, determine the best location for your battery, think about where to put a bus bar, and so forth during the initial aircraft integration stage itself.

At the hangar, this week's progress focuses on the electrical and avionics system loom installations. An interesting activity that is in operation points to the 'loom continuity checks'. These 'continuity checks', check the electrical resistance between the contacts within the jack and a mating plug and there should not be any resistance measured which indicates that the continuity is good. This test needs to be conducted using a mating plug that is in a new condition. The mating plug terminals should be as clean as possible, and show no signs of wear, tarnishing, or other deterioration of condition.



Mr Pandurangan, Quality Control Manager, is of the opinion that 'It is imperative that each and every bunch of loom terminating at the cockpit (which in turn contain numerous strands of wires), need to be thoroughly checked to ensure that all vital electrical signals are coming through nice and clear and without any interference'. Grouping the different bunch of looms is an extremely important aircraft safety exercise that needs to be judiciously carried out. Here, it may be apt to recall Ben Sclair (aviation fuels expert), that 'electricity has its own place in this world, but one place that it shouldn't be is near the fuel filler neck'.

At another corner of the hangar, it is seen that the ejector system pressure test fixture has been completed and pressure tests up to 205 psi are being planned. On the aircraft side, the ventral fin has been neatly mounted. At the far end of the HANSA hangar, structural test on the stub wing assembly is through and is awaiting final clearance from the DGCA before its removal from the jig.

As I begin packing my camera kit, the picture of so many wires sprawled around the aircraft looms large before me. Would I be right in saying, 'It's much better to find a short-circuit now before it finds you'?

R Guruprasad with Suju Thomas

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'The Clamps That Can Read the Ohms'

#IP 743 11 - 17 Dec 2006

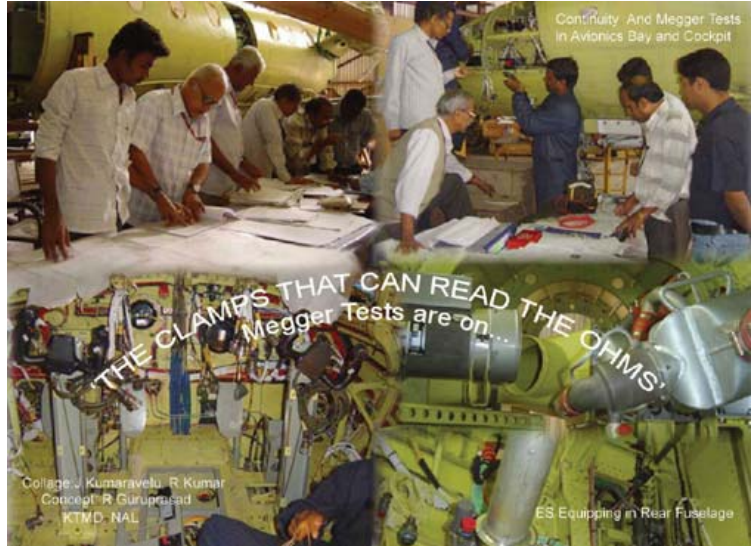
This week's activity focuses on important 'insulation resistance tests', more popularly called the 'Megger Tests' which are currently in progress on SARAS. With the electrical looms in place, properly routed and labeled, these tests are an absolute DGCA requirement for aircraft readiness.

Essentially, these 'Megger Tests' comprise of megohm meters that are scaled to read in megohms or millions of ohms. The main objective is to measure the total resistance between any two points that are separated by insulation. These tests are carried out to find out the effectiveness of the insulation.

The ALD and C-CADD colleagues deserve our warm appreciation in completing all the avionics and electrical requirements of the SARAS aircraft in record time.

Other significant progress this week points to ECS equipping in the rear fuselage where the installation of ECS pack, ground cooling fan and other related duct assemblies have been completed.

R Guruprasad with Suju Thomas



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'Light At The End Of The Tunnel' **#IP 744 18 - 24 Dec 2006**

This weeks' activities are focused on powering the aircraft. All tests on the electrical wiring have been completed. The power on checks are in progress to all the distribution points in the aircraft.

This is a major milestone towards commencement of functional checks on all the mechanical and electrical systems on the aircraft.

Getting a good digital telephoto shot of these long, extremely reliable and rugged AC duct pipes from the rear end of the aircraft, I realize that days and months have passed since work began on the SARAS PT II.

As I leave the hangar and make my way back through the busy streets of Bangalore, it's clear that the festive mood is on and in full swing. Colourful stars prominently adorn the house tops symbolizing high hopes and ideals, a hope for good fortune and to reach above oneself.



Our hopes and ambitions are also running high as the 'Light at the end of the tunnel' is just round the corner.

R Guruprasad with Suju Thomas




SARAS Picture Gallery

Activities: Week of 18 to 22 Dec.2006

*Slide Presentation Layout
and Photography:
R Guruprasad, Suju Thomas and R Kumar*

Are We Approaching 'The Lights at the End of the Tunnel..'

Aircraft ready for power on

Power on checks in Cockpit and avionics bay



'Getting Decked Up for the New Year' **#IP 745 25 - 31 Dec 2006**

As far as this week's SARAS round up is concerned, the 'power on checks' of all the electrical wiring leading to cockpit equipping have been completed. The preliminary DGCA inspection of the loom installations have also taken place.

The inspection on critical mechanical systems like the Flight Control Systems (FCS), hydraulics, power plant and the fuel system is through. Tuning up of FCS is being carried out.

As the New Year dawns and we begin earnestly penning our resolutions, tighter resolutions are being framed to herald the New Year at the hangar. A 'fully equipped cockpit' and timely initiation of 'functional tests' are the immediate targets.

We sign off this week's round-up with a 'Happy and Prosperous New Year Wishes to all our readers'.

R Guruprasad with Suju thomas.

SARAS Picture Gallery

Activities: Week of 25 to 29 Dec.2006

*Slide Presentation Layout
and Photography:*

R Guruprasad, Suju Thomas and R Kumar



Cockpit – ready for equipment



Fire warning panel & OHP



Hydraulic and pressure
refuelling line



Fuel system in rear belly



Master Box & GPU



MIP – ready for cockpit
fitment



‘Progressing Ahead To Ensure A Safe Landing...’

#IP 746 1- 7 Jan 2007

A Significant milestones have been reached this week with regard to the SARAS integration activities. Some of these are: the finalization of control column and aileron circuit. I also notice that the inspection of cockpit installations have been completed. At the same time, work on the oil cooler inlet line is also through.

Another important activity which I see in operation is the preliminary rigging of engines which is nearing completion.

The hydraulic installations have been completed and preliminary system checks pertaining to the landing gear along with wheel and brake system have also met their deadlines.

As we move towards functional checks of vital mechanical systems leading to the engine run, I notice extreme care is being taken to ensure that the critical hydraulic system and the landing gear are put to the most rigorous tests.

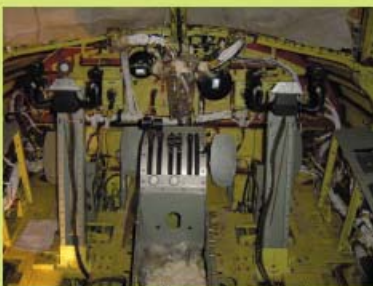
It may not be totally wrong to say here that ‘Every takeoff is optional, but every landing is mandatory’

R Guruprasad with Suju Thomas

SARAS Picture Gallery

Activities Week of 1 to 5 Dec.2007

*SARAS Through the Lens
R Guruprasad with R Kumar*



Finalisation of control column in cockpit



Main landing gear



Oil cooler inlet line



Hydraulic installation in MLG bay



Nose landing gear

Hydraulic installation in NLG bay





'The Noise Shielders...'

#IP 747 8- 14 Jan 2007

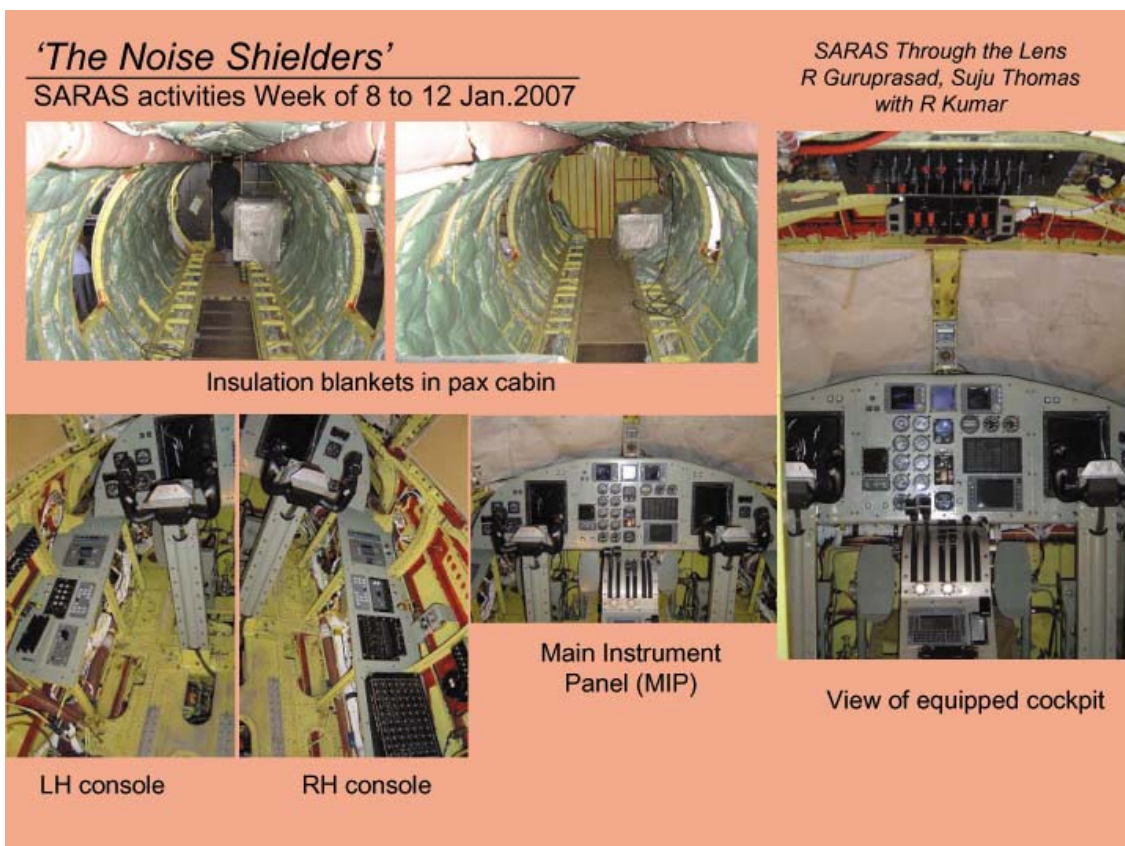
This week's progress shows SARAS fuselage in a completely insulated condition. This thermal and acoustic insulation system (made of Polyfab) used in SARAS, is a multi-layer design that addresses unwanted airborne and structure-borne noise. Most importantly, without adding too much additional weight.

Aviation experts opine that 'one must eliminate all gaps and openings into the aircraft. This could be done using soft closed cell foam or silicone caulking to close every opening. Once 'air tight' noise cannot enter directly into an aircraft. At the same time, one needs to add or replace foam or rubber cushions under any structures that can rattle like cowlings against the fuselage, oil filler doors, trim panels against the fuselage, etc'.

The other interesting events at the hangar that needs mention this week, are: Main Instrument Panel (MIP) installation in the cockpit and the equipping of the LH & RH consoles which have been completed.

I leave the hangar with a happy note that the day we get lucky to travel in our SARAS 'Good Comfort is a certainty as we never compromised on the vital insulation strategies'.

R Guruprasad with Suju Thomas





'Filling it up to the Brim...'

#IP 748 15 - 21 Jan 2007

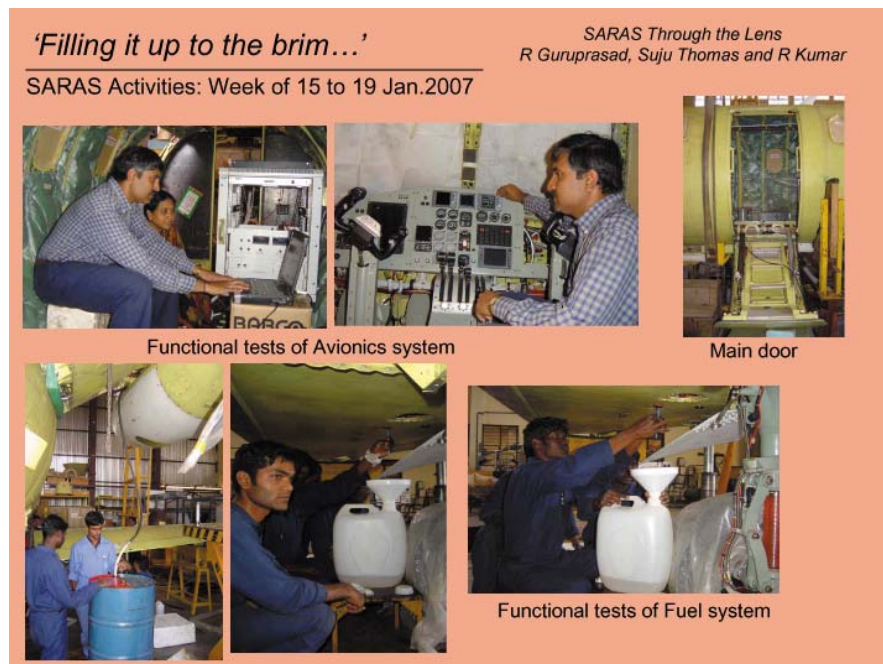
The SARAS activities this week turns our attention to the functional tests of the various systems of the aircraft. The first of those systems that have been successfully tested is the fuel system. It's interesting to note here, that the LH and RH wings of the SARAS aircraft together can hold close to 1,650 litres of aviation fuel. Siphoning out aviation turbine fuel from huge drums and then transferring them carefully (with exact measurements) onto the aircraft fuel tank is a very calculated affair. Fuel gauging tests which commenced around 5 pm, went on till the wee hours of the morning for two consecutive days.



Tests included capacitance gauging, quantity checks and flow rates to ascertain the max. fuel that could be filled in the aircraft. And, most importantly, whether the supply system to the engine was satisfactory. Test results were then matched with the earlier measured fuel gauge and flow rate indicator readings to ascertain the correctness of fuel flow. In fact, carrying out this exercise, greatly aids in spotting leakages, if any, and take suitable remedial action. These tests have been carried out in 2 configuration, i.e., level flight and cruise attitude (3 deg nose pitch up) Inside the aircraft, tests on the avionics system related to the power plant system have also been completed.

With a good cleansing of the fuel system, SARAS seems to be saying – 'Fill me up to the brim now, I am raring to go up into the blue Indian skies'

R Guruprasad with Suju Thomas





'Deft Maneuvering with my FCS...'

#IP 749 22-28 Jan 2007

Functional checks of the flight control systems is the most significant progress that I notice in this week's reporting of the SARAS events. The important activities of the functional tests comprise of certification tests such as limit load test, breakout forces test and the circuit stiffness tests.



These tests were carried out for the ailerons, rudder and elevators as per the test schedule and all parameters met our expectations.

Subsequently, the operations of the flaps have been vigorously tested from zero to landing configuration and found to be working fine.



By about 4 in the evening, SARAS, seemed *basking in the sunlight*, just out of the hangar and ready for the first engine cranking test. The 'elated mood' at the hangar portrayed reaching of another milestone. The event, aptly coincided with 'the *traditional coconut breaking ritual*'.

My colleagues Rajeev Kandral and Radhakrishnan were at the

'Deft Maneuvering with my FCS..'

SARAS Activities: Week of 22 to 26 Jan.2007

SARAS Through the Lens
R Guruprasad, Suju Thomas, ABS Vijay and R Kumar



Functional Tests for Elevator



Functional tests for Rudder



SARAS Flaps in Operation

helm of affairs monitoring this event. On satisfactory completion of the cranking, they said, 'both the engines cranked well, and we are moving ahead for the first engine ground run tomorrow morning'.

Dr A R Upadhya, Director, NAL was present to witness this significant event and the mood at the hangar was a '*sense of immense pride and satisfaction*'

R Guruprasad with Suju Thomas

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'The Beauty and the Beast...'

#IP 752 12-18 Feb 2007

SARAS and HANSA went through 'rigorous air drills' before they moved onto the Yelahanka Air Base to be in fine shape for Aero India 2007. This year's air show was professional in all aspects in view of the efforts of Ministry of Defence, FICCI and Farnborough International Ltd. to host this event.

This year's air show threw open a plethora of opportunities for one and all. It became the ideal platform for the various aviation giants to stake their claims and showcase their products in order to try making their entries into the Indian market.

Our own 'two flying machines' looked rather dazzling on the Yelahanka tarmac with their fresh coats of paint and their 'heart-warming Indian tri-colour stickers' prominently catching our eyes.

Speaking to Mr Shijo K Francis (HANSA flight operations in-charge), I learnt that HANSA had two fruitful flights on each day of the Air Show. One around 11:00 in the morning and the second around 4:30 in the evening. It was brilliantly maneuvered by AVM A S Lamba (Retd) with excellent 'wing-overs', 'steep turns' and 'steep climbs', ably justifying its sport, hobby flying and two-seater trainer aircraft capabilities. HANSA evoked a lot of enthusiastic response right through the show and we are definitely in for pleasant surprises!

SARAS was piloted by Wg. Cdr. R S Makker, the chief test pilot of ASTE and his crew. Speaking to him, I learnt that SARAS had sorties on all the days of the show. However, on the first day it made three sorties. To keep the audience enthralled it flew as low as 500 ft and the well-noticeable 'banking' angles were



about 60-65°. Most importantly, it flew with max.all up weights and to the delight of every Indian completed its 100th test flight during the course of this air show. The 100th milestone was aptly rejoiced through prominent announcements made on the public broadcasting system and a pastry distribution ceremony in the NAL stall. SARAS ground operations were ably handled by Mr. Radha-krishnan.



As the Aero Exhibition finally culminated into a grand finale on the 11th, our own 'two little flying birds' touched the hearts of many proud Indians. In a way, the 'Beauty(s)' had truly overcome the 'Beast(s)' with their own 'poise' 'grace' and 'maneuvering elegance'.

R Guruprasad with Suju Thomas

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'The Crescendo, Aftermath and Back to Serious Business..'

#IP 754 26 Feb - 4 Mar 2007

It was without any doubt in the minds of the aviation experts and enthusiasts that NAL's HANSA and SARAS asserted their position in the recently concluded Aero India 2007. Both static and flying displays sent the crowds into an euphoria. SARAS's fly past on 7 February 2007 along with 21 other aircraft was indeed a delight to watch and would go down as one of the most memorable events in the history of Indian civil aviation in the years to come. A performance, immensely credible, in view of the fact that SARAS is still very much a prototype, with barely 65 hours of flight testing.



LRUs' on partition wall



FCS Calibration

The engineering expertise and maturity that went into the building of SARAS was all the more visible at the air show. The warm hugs of triumph, accolades and handshakes has gradually tapered down at the Yelahanka airbase. Now, the main-stream focus is once again back at the C-CADD hangar.

The progress on the second version of SARAS has not lost its momentum inspite of NAL's stupendous achievement at Aero India 2007.

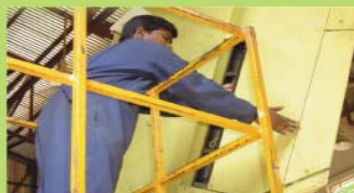
Deadlines are coming closer towards the commencement of another major milestone, i.e. engine ground runs on the SARAS which will start in a few days

'SARAS Picture Gallery'

*SARAS Through the Lens
R Guruprasad, Suju Thomas,
and R Kumar*



Calibration of trim tabs and
FCS movement checks



NWS checks



from now.

Stringent checks on the aircraft with regard to hydraulics, electrical, avionics and FCS is nearing completion. The process of obtaining the formal clearances from DGCA is under progress and the airframe structure, power plant, fuel system and hydraulics system has been cleared by DGCA so far. After the DGCA clearance of FCS, electrical and avionics system, the 2nd baby would roll-out to ASTE. Then begins a series of full fledged engine runs and low-speed taxi tests eventually leading to the first flight.

R Guruprasad with Suju Thomas

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‘A Moment That Comes...But Rarely in History...’
#IP 755 5 - 11 Mar 2007

2nd March 2007 turned out to be a 'Red Letter Day' at the SARAS Hangar - a milestone deserving our warmest appreciation, a day of stupendous rejoicing. Most importantly, a historic event, that would go down into the annals of Indian civil aviation history.



I reach the hangar around 3.45 p.m. The atmosphere is totally festive. Team SARAS is in a jubilant mood. At every corner of the SARAS hangar, hand-shakes and warm



hugs seemed to be the 'sweetest menu' of the evening.

SARAS's 100th flight took place on 10th February 2007, i.e. the 4th day of Aero India 2007 with a beautiful air display. To commemorate this event, the



management of NAL chose 2nd March 2007 to celebrate this most significant and well-achieved milestone.

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'SARAS Picture Gallery'

Activities Week of 05 to 09 March 2007

*SARAS Through the Lens
R Guruprasad, Suju Thomas,
D Freddy, D Gopalakrishna, ABS Vijai,
R Kumar, J Kumaravelu*

SARAS Successfully Completes 100 Flights



With our achievements in Aero 2007, It was clear to everyone that the development of the SARAS prototype has truly been an 'engineering marvel' and 'our nation's pride'.

Dr A R Upadhyaya - Director, NAL, Dr K Yegnanarayan, Mr M S Chidandanda, Dr T S Prahlad and Wg. Cdr. Makker representing NAL and ASTE respectively shared their rich experiences from the time of the conceptualization of this 'novel project' to its present realization. It has been a long and arduous journey worth all the effort.

The SARAS programme itself has been a classic example of a 'great synergy venture' and undoubtedly the biggest 'comrades' who stood by us right through our torrid and also happy times were these group of Air Force 'test pilots' from ASTE who took up this challenging task of flying the SARAS prototype, thereby proving its 'design capability'. All the Commandants of ASTE and the Chiefs of the Air Force led from the front and strengthened this NAL-ASTE bond with their continued support.

It would only be very apt to end this weeks' article recollecting Pandit Nehru's 'soul stirring' speech made on 14 August 1947 - "Long ago we made a tryst with destiny...a moment comes, but rarely in history..."

HANSA and SARAS are true embodiments of a 'liberated, vibrant and independent India'. Moments like celebrating the 100th flight of SARAS also comes - not often, 'but rarely in history'.

R Guruprasad with Suju Thomas

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“SARAS Has Completed 100 Flights Flamboyantly!”

A report on “participation of SARAS for the flypast and flying demonstration at Aero India-2007”.

The first ever indigenously designed and developed light transport aircraft - SARAS by NAL, after having successfully demonstrated its flying abilities in Aero India 2005 held at Bangalore, asserted its presence in the international aviation scenario again by participating in the just concluded Aero India 2007. It was the only prototype aircraft that participated in both static display as well as flying demonstrations from 07 Feb 07 to 11 Feb 07 at the Aero India 2007. The SARAS aircraft could achieve this formidable feat with just about 65 hours of flight testing, thus proving the maturity of its design and robustness of the platform.



The idea to give a new look to SARAS for the Aero India 2007 was in everyone's mind. However, it was put forward explicitly by the SARAS Project team including the flight crew. Towards this, a colleague of my wife who is a graduate of Chitrakala Parishad, Ms Babitha Bhaskaran was requested to help us design 'streaks' of vibrant colours to make SARAS look majestic. She did oblige us with her creative skills and in about half a day crafted various designs / colour schemes to choose from. Finally, the current pattern of 'streaks' appealed to every one's eyes instantly. In the “India Poised Year” of 2007, with the chosen design pattern depicting the bird in flight and the national tri colour scheme, like India, Saras is all set to be “Poised”.



The demonstration of SARAS aircraft in Aero India 2007 began with rigorous preparations comprising of exhaustive planning of manoeuvres for the flying demonstration, accurate route navigation for the flypast, thorough flight briefings, critical post flight debriefs and a quick look post flight data analysis. These activities were spread over several practice sorties flown over Bangalore

and Yelahanka airfields. Every sortie was a significant step towards the final goal of flawless and immaculate flying demonstration of SARAS by ASTE flight crew.

The impressive flying demonstration of SARAS aircraft during Aero India 2007, that won accolades from all the quarters alike, was planned, directed and flown by Wg Cdr RS Makker, Chief of the SARAS Trial Team and his crew with critical inputs from the test director Wg Cdr P Ashoka VM & Bar. The ground crew, the inspection team and the telemetry team provided the requisite background support. During the Aero India 2007, the SARAS aircraft completed its 100th flight on 10 Feb 07. Dr AR Upadhya, Director NAL, Dr TS Prahlad, Consultant NAL, Wg Cdr P Ashoka, Flight Test Director, Air Cmde M Matheswaran, VM, Commandant, ASTE, Air Cmde P P Reddy, VM and Gp Capt B.R. Krishna, SC were present on the occasion. To celebrate the 100th flight, Wg Cdr Arun Malik, Wg Cdr MSR Mohan, Wg Cdr Anil Goyal and Sqn Ldr S Elayaraja, smuggled in a commemorative cake for a quiet celebration. And they told me that there would be a “Special Debrief” after the sortie.

The hugs and handshakes continued for a long time after the flight. All test crewmembers were touched by the entire team’s warmth and visible sense of pride in the achievement of this special milestone. The “special debrief” in the form of ‘cake cutting’ was conducted in Flight Display Director’s office with Project Director doing the honours.

This stupendous and memorable feat of participation in Aero India 2007 was a result of team effort of the SARAS trial team with valuable guidance of the Director NAL, Flight Test Director, Programme Director and the Project Director (SARAS), CQCM-SARAS from NAL and Commandant ASTE and Flight Display Director of Aero India 2007 and his team members. The unstinted efforts of the designers, ground crew, inspection team and the entire supporting staff including telemetry team bore fruit during the Aero India 2007 when one and all deeply appreciated the flying demonstration of the SARAS aircraft. At the end of the Aero India 2007, a sense of satisfaction and pride was visible on the faces of the entire NAL and ASTE family.

By Wg Cdr RS Makker

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“On my way to my second home to accomplish a new milestone..”
#IP 756 12-18 Mar 2007

SARAS moved on silently to its second home at ASTE without any pomp or paraphernalia on 9th March 2007 for its scheduled engine ground runs. In the next few days, it would be subjected to PT-II final readiness tests, full power EGRs, LSTs, HSTs and finally, the much awaited first flight.



SARAS Engine Ground Runs are On..

I reach the hangar around 11:00 a.m. on 13th March 2007. SARAS is occupying its prominent place in the west end corner of the ASTE tarmac. The ‘majestic yellow’ coat of paint is prominently shining in the sunlight trying to match nature’s own rays. This ‘yellowishness’ is ably compounded by



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the beautiful flowers from the adjoining 'Golden Bell tree' at the tarmac.

Wg. Cdr. Mallik, before the commencement of the engine run is quick to remark that - 'Looks like I am about to enter an oven'. Many of us know that SARAS is not yet pressurized and is going through the rigours of the engine runs in these present hot weather conditions.

Wg. Cdr. Makker takes charge of the operations around 11:20 a.m. and the aircraft is then put onto a rigorous engine run for close to an hour during which a number of different parameters were checked as per the power plant system test schedule.

After the run, Wg. Cdr. Mallik is the first to come out of the aircraft, heaves a sigh of relief, and quickly adds, "I don't have to visit my health club in the evening for another 'Sauna'". Sometimes, critical tasks push mankind beyond limits.

At the other end, Wg. Cdr. Makker, Wg. Cdr. Ashoka and Rajeev Kandral look satisfied with the results of the run. Most importantly, it is to be noted here that PT-II has a newly designed oil cooling system. Its efficiency during the engine runs have been very good due to its innovative design. Hence, it's not surprising that most of the engine temperature parameters are well within the acceptable limits.

Today's engine run happens to be the 9th in its schedule and the engines were run at max torque.

As I leave the ASTE Tarmac, I ask to myself as to what is this unique *Siamese Twin* connection between the SARAS engine runs and this sweltering summer – *Maybe, one cannot be without the other.*

R Guruprasad and Suju Thomas

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“I’m Eager to get a Feel of the Runway” **#IP 757 19-25 Mar 2007**

PT-II went through close to 15 rigorous EGRs (Engine Ground Runs). The flight crew and the NAL experts felt that the aircraft is now ready to progress to the next phase.

There’s some good news for all our NAL colleagues. The Flight Readiness and Review Board (FRRB) in its meeting held on 20 March 2007 has cleared SARAS PT-II for its low speed taxi trials. They have now sent all the relevant set of documents to DGCA, Delhi for their final clearance. The DGCA R&D team is



‘SARAS Picture Gallery’

Activities Week of 19 to 23 March 2007

*SARAS through the Lens
R Guruprasad, Suju Thomas,
R Kumar, J Kumaravelu*



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expected to make one further inspection to ascertain the aircraft of its readiness and finally blow their 'whistle' for the Low Speed Taxi Trials (LSTTs).

Meanwhile the aircraft is undergoing further EGRs to carry out dynamic balancing of propellers before flight and also to carry out elaborate EMI/EMC checks.

One last look at SARAS before leaving the ASTE Tarmac gives me an impression that "she is now too eager to get onto the runway to mingle with the other big birds"

SARAS will soon commence its low speed taxi runs, proudly and prominently displaying its 'VT-XRM' identity. What else could be a more befitting way of saluting one of NAL's pioneering aviation dreamers, (Late) Sri Raj Mahindra.

R Guruprasad and Suju Thomas

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“Limbering Up Before Final Take Off...”

#IP 758 26 Mar - 1 Apr 2007

SARAS Low Speed Taxi runs have begun in the right earnest and are going on as per the schedule. Three low speed runs have been completed as on 24/03/07.

Immediately after the second run on 24/3/07, I catch up with Wg. Cdr. Makker and Wg. Cdr. Malik, chief test pilots to get their first hand impression on PT-II's performance.

Makker and Malik graciously opine that, “Pre-flight formalities, engine start and after-start checks went off smoothly – *no surprises*. PT-II appears to be a good platform to maneuver.

Nose-wheel steering is very well tuned. Responses to steering inputs are consistent. There's no doubt that PT-II appears to be a powerful machine.” He further adds that, “satisfactory functioning of all the aircraft systems is itself the best proof of the excellent design and maturity to which this programme has reached”.



SARAS PT-II LOW SPEED
TAXI TRIALS AT HAL RUNWAY
23, 24 March 2007

Collage: J. Kumaravelu and R. Kumar

From the Flight Test Director's perspective, Wg. Cdr. P Ashoka is of the opinion that, “for a new prototype all the taxi runs so far have gone on very smoothly and brake temperatures are well within the limits. Most importantly, the new ejector system for engine oil cooling is proving to be very effective. The aircraft handling is also fine”.

Wg. Cdr. Rama Mohan adds that, “all aircraft systems have been well integrated and the aircraft functionality and system operability are very much similar that

observed on PT-I. Results attained so far are well within the design limits and no major deviations have been noticed”.

As we move onto to April 2007, the ASTE Tarmac will soon witness another euphoric moment of champagne corks fizzing open. The Indian tri-colour would be held well aloft, swaying prominently to aptly signify reaching of another great milestone.

R Guruprasad and Suju Thomas

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“An Odyssey Called SARAS...”

#IP 759 2- 8 Apr 2007

Flight has always symbolised man's ceaseless quest to explore the limitless sky in an unfettered freedom beyond all horizon. Charmed by the glorious sight of the birds flying merrily in gay abandon enjoying the mother nature to the fullest, man tried his best to emulate them, not by leaping into the sky, but by gradually and progressively improving his abilities to fly in man made machines.



SARAS,
the very
name
conjugates
up
delightful
vision of
a
graceful,



elegantly beautiful bird, pristine in its purity and majestic in its sheer grandeur. So the aircraft manufactured by NAL was aptly named for its beauty and grace. Nearly three years have passed since SARAS for the first time, shook off its shackles to soar into the sky. From the initial unsure hesitant and fledgling steps, that it took on its arduous momentous journey, it has come a long way. The first SARAS PT-1 completed a century of flights during the Aero-India 2007 dazzling one and all, by its graceful flying. The sheer maneuverability and agility of its display amply demonstrated the enormous capability, as well as the maturity of the programme, and the great synergy between NAL and ASTE.



Come April 2007 the PT-2 of SARAS will also take to the sky showcasing the growing strides the programme is making. The PT-2 has finally moved out bidding its home and hearth NAL a fond farewell. PT-2 completed full complement of 12 EGRS. Now nestled at ASTE, SARAS PT-2 took its first steps (confident this time) on 23 Mar 07 as it commenced its Low speed Taxi Trials. Having set forth on its intended path the SARAS PT-2 is well on its way to its first flight. During the initial maneuvering in the taxi trials, the aircraft displayed amazing stability and a crisp, predictable and easy controllable response to all crew

inputs. All engine parameters were stable. The satisfactory functioning of all the aircraft systems was a proof of an excellent aircraft design. God speed and many happy landings to PT-2 and the entire programme.

Wg Cdr RS Makker & Wg Cdr A Malik

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“Gathering Sufficient Momentum to See My NoseWheel Lift”

#IP 760 9-15 Apr 2007

An FRRB sub-committee which met on 11 Apr 2007 has cleared SARAS for its three SOP runs (Standard Operating Procedure runs) and subsequently for its maiden flight.

On a blistering 12th afternoon, SARAS completed the first of its SOP runs. The run commenced around 1:30 in the afternoon and went on till about 2 p.m. After the run, Wg. Cdr. Makker in his de-brief mentioned that, “all basic aircraft and engine parameters were fine and the taxi run was smooth and satisfactory”. SARAS reached a max.speed of 90 knots during this SOP run. The peak brake temperature recorded was around 380 deg”.

Well, over the last fortnight, things have happened at a real blazing speed at the ASTE Tarmac. SARAS has effortlessly completed four low speed taxi trials and four high speed taxi trials. These runs eventually culminated with an elegant ‘Nose-Wheel-Lift’ on 7 Apr 2007.

It was an absolute delight to behold. All the vital parameter readings are very much within the tolerance level, and all the integrated systems on the aircraft are working with a high degree of precision.

It’s mandatory that three consecutive SOP runs need to be successfully completed without any snag in order to be ready for the first flight.



Collage: J. Kumaravelu, R. Kumar
Concept: R. Guruprasad
KTMD, NAL

Today, I happen to be lucky to be tucked inside our SARAS chase van to get a much better angle on my digital camera. SARAS on the runway in such close quarters can undoubtedly be quoted as '*a thing of beauty is a joy for ever...*'

As the aircraft veers in the direction of ASTE after the SOP run, my thoughts only fervently say that, '*Aren't We Almost There?*'

R Guruprasad with Suju Thomas

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“SARAS PT-II Countdown to the First Flight..”

#IP 760 9-15 Apr 2007

As the Saras PT2 waited patiently to set soar on its maiden flight, the build up to this momentous occasion continued quietly by the side. The Saras PT2 commenced its confident steps in the form of Low Speed Taxi Trials (LSTT) on 23 March 2007 to assess the aircraft controllability and functionality of various aircraft systems. By 3 April 2007, slowly but steadily, the aircraft continued to inch forward towards its goal of first flight.



The LSTTs were completed paving way for the ac to commence the High Speed Taxi Trials (HSTT). A maximum speed of 52 kt was achieved during LSTT. The aircraft controllability was adequate and the integration and functionality of various aircraft systems was satisfactory. Based on the results of LSTT the Flight Readiness Review Board (FRRB) accorded “Go-Ahead” for the HSTT and Standard Operating Procedure (SOP) runs.

All four HSTTs were successfully completed by 9 April 2007. The power packed Saras PT2, which is equipped with the new power plants was akin to unleashed Arabian horses on a racecourse. During the HSTT runs, Saras PT2 was raring to get airborne. The flight testing during HSTT was designed to assess this natural capability of the Saras PT2 though remaining under full control of the Pilots.

On successful completion of HSTTs on 9 April 2007, a sub committee of FRRB accorded clearance for the much awaited first flight of Saras PT2. The scorching summer heat reminds us of the green house effect, which is causing lot of “joy” to the avionics equipment and the test crew during the runs. To ward off the heat and keep both avionics and the test crew “cool”, fans were installed in the cockpit and the avionics bay. However, the fans installed in the cockpit blow “hot and cold” as it is re-circulating the hot air in the cockpit.

This heat treatment of the test crew is tempering them for the gruelling path ahead before the first flight of Saras PT2. The telemetry team is back in action with every group clamouring about various parameters and scale factor. In fact, telemetry tasks are well delegated amongst the members of the telemetry group. The ac integration team is generally in control of things – like a “Hawkeye”.

The crash and chase team have fine-tuned their drills to take on any eventuality. The untiring efforts and valuable guidance of Project Director ensures that the spirits of “Team Saras” are always high. The tempo is building to the crescendo! All events have fallen in place like the pieces of jigsaw puzzle. Now,.... It is the final count down!

Wg Cdr R S Makker and Wg Cdr MS Ramamohan

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"SARAS PT2 Makes Maiden Flight"

#IP 761 16-22 Apr 2007

The second prototype PT2 of the 14-seater multi-role Light Transport Aircraft SARAS had its successful maiden flight on 18 April 2007 at 09 05 hours. SARAS is being developed by the National Aerospace Laboratories (NAL) of Bangalore, a constituent unit of the Council of Scientific and Industrial Research (CSIR) and is the first indigenous civilian aircraft of the country.

The maiden flight of SARAS was conducted by Wg. Cdr. R.S. Makker as the Chief test pilot – SARAS, Wg. Cdr. A. Malik as the co-pilot and Wg. Cdr. M.S. Ramamohan as the flight-test engineer, all belonging to Aircraft Systems and Testing Establishment (ASTE) of the Indian Air Force, which is identified as the flight testing organization for SARAS.



The first prototype (PT-1) of SARAS had its maiden flight on May 29, 2004 and its formal inaugural flight on Aug 22, 2004 in the presence of Sri Kapil Sibal, the Hon'ble Minister for Science & Technology. Till now 106 flights of SARAS PT1 have successfully been conducted, including in the Aero India airshows of Feb, 2005 and Feb. 2007.



Several improvements have been made in SARAS design from PT1 to PT2. The most important one among these is the incorporation of two higher power engines PT 6A-67A of 1200 hp each in PT2 in place of PT6A-66 of 850 hp each used in PT1 and new propellers of larger diameter. This is particularly done to meet the stringent climb gradient requirements under one engine failure condition as stipulated by Federal Aviation Regulations –25 (FAR-25) of USA, the certification standard for SARAS. The higher power engines will also improve the other performance characteristics of SARAS. The supporting stubwing structure and the engine nacelle were also modified to suit the new engine. Improvements have also been incorporated in flight control system layout, flap operating system, avionics and electrical system layout etc., taking into account the inputs received from the flight crew and maintenance staff. All these improvements have brought PT2 much closer to the final production standard aircraft.

Parallely, a weight optimisation programme has also been taken up for SARAS, with a target of 500 kg weight reduction, through optimisation of metallic structures, stringent fabrication control, increased use of composites etc. An additional prototype will be built to the final production standard and proved through a combination of ground and flight-testing. The FAR-25 standard certification by the Director General of Civil Aviation is targeted for the end of 2009.



Discussions are progressing with the Indian Air Force which is likely to be the launch customer for SARAS for meeting some of their transport and training requirements and also with HAL for productionising the aircraft. The aircraft performance will be demonstrated in PT2 to the Indian Air Force by simulating the all up weight of 7100 kg. After some further data is gathered, discussions will also take place with the Ministry of Civil Aviation and various operators for utilization of SARAS in regions like the North East and in other roles like feeder aircraft, light cargo aircraft, air ambulance etc.

With the present boom in civil aviation and the recognized need for air-networking different parts of the country including smaller towns, SARAS will have a distinct role to play in establishing air connectivity, bringing people together and in the overall economic development of the country. The maiden flight of PT2 is thus a very important milestone in that direction and in ultimately establishing a viable civil aircraft industry in the country.

The SARAS second prototype aircraft VT-XRM with the new, more powerful engines (PT6A-67A), took off from the Bangalore Airport at 09 05 hrs and the flight lasted about 40 minutes. The aircraft climbed to an altitude of about 9000 ft. and reached a maximum speed of nearly 150 knots. The pilots executed several mild maneuvers to get a feel of aircraft handling qualities. The landing was perfect as indeed were the other phases of flight. The flight crew reported that the aircraft handled as expected and there were no surprises. The flight parameters were normal and as expected. Wg. Cdr. R.S. Makker, Chief Test Pilot said after the flight that –

“The present SARAS with new engines appears to be a very potent and powerful machine, with all the aircraft systems performing precisely in the first flight itself, only goes on to show the professionalism of the entire TEAM SARAS”.

K Yegna Narayan and M S Chidananda



“Up Above the World So High.. Like a Diamond in the Sky..”
#IP 762 23-29 Apr 2007

I reach the ASTE hangar just about 8.00 a.m. in the morning. It was a rather hazy morning.

Wg. Cdr. Makker, his test pilot crew, senior commanding officers of the ASTE and the entire fraternity of Team SARAS are in the midst of a most important briefing. SARAS stands majestically inside the ASTE hangar with all flight readiness checks completed as early as 7:00 a.m. The briefing gets over around 08:15 a.m. and the pilots immediately commence their pre-flight checks.



The tension is palpable. Wg. Cdr. P Asoka, flight test director conveys his wishes to the pilots before moving over to occupy his prominent position at the telemetry station. The telemetry team begin their business in the right earnest.

SARAS engines come on with a thundering boom. PT-II is fitted with two powerful Pratt and Whitney Engines (PT6A-67A). The power of twin 1200 hp engines is clearly distinguishable from that of the 850 hp engines of PT-I. The larger diameter white-coated propellers and the new coat of yellow paint on SARAS ably give company to the early morning sun at the tarmac. A hot and sultry day is ahead for all of us.

While the pilots go for their flight checks, the chase Kiran is all set to leave the ASTE tarmac to accompany SARAS. With both the engines in full motion, SARAS elegantly moves away from ASTE around 9:00 a.m. A large number of our NAL colleagues have gathered by now at the ASTE hangar to witness this historic moment, just a few minutes from now.

I quickly jump onto the ground chase crew van with Radhakrishnan to once again get as close shots as possible. Radhakrishnan is generous to give me the best vantage position.

We are now at the end of runway 27. HAL ATC welcome Wg. Cdr. Makker and his crew with a 'very good morning' before according their final clearance for 'take off'. Flight test director also gives his okay.

To everyone's delight SARAS takes off around 9:05 a.m.

Hence, it would not be wrong to recollect two very apt quotes of similar first flights that took place in the aviation history much much earlier:

Suddenly, Santos-Dumont points the end of the machine skyward, and the wheels visibly, unambiguously, leave the soil: the aeroplane flies. The whole crowd is stirred. Santos-Dumont seems to fly like some immense bird in a fairy tale - 'Le Figaro,' first powered flight in public, 24 October 1906.

The hardships and perils of the past month were forgotten in the excitement of the present. We shook hands with one another, our hearts swelling with those emotions invoked by achievement and the glamour of the moment. It was, and will be, perhaps the supreme hour of our lives. - Sir Ross Smith, K.B.E., first from London to Australia.

It would also be apt at this point to recall the following statement from the hero of the second world war.

Sir Winston Churchill - "Sure I am that this day we are masters of our fate, that the task which has been set before us is not above our strength, that its pangs and toils are not beyond our endurance. As long as we have faith in our cause and an unconquerable will to win, victory will not be denied to us".

After all the pomp and celebrations that finally culminated at the ASTE tarmac, I quickly leave the Belur Campus and veer my vehicle onto the busy Airport Road. While quickly passing through the Air Force School at the corner, my ears quickly resonate to the bunch of tiny-tots merrily singing their popular nursery rhyme, "..Up above the World So High. Like a Diamond in the Sky.."

"Yes, "..Up Above the World So High. SARAS shone like a Diamond in the Sky..".

"SARAS flew like a PEGASUS"

*Excerpts of an interview with **Wg Cdr Makker, Chief-Test Pilot, SARAS after the first flight of SARAS PT-II***

I ask Wg Cdr Makker, from the pilots perspective, how was the take-off?

The take off distance was about 2700 ft. from runway 27 end, the unstick speed was around 118 knots, initial climb attitude was pretty steep. After climbing through 800 ft, we throttled back to 70% TQs, speed checks on ADC1 were absolutely on par with Kiran aircraft – the chase ac for the flight. The rate of climb was quite good and was around 1700-1800 ft/min with undercarriage extended. The Kiran had difficulty in keeping pace with this rate of climb at 130 knots with SARAS.

What were your feelings on the lift-off and the first flight?

SARAS lift-off and the first flight of SARAS were nothing short of - 'Pegasus' (son

of 'Poseidon', and the 'winged-horse' of the Greek mythology known for its poise, speed and grace). Absolutely wonderful!

What was the flight path that was scheduled for the first flight?

We followed the Mysore road rail line till Ramnagaram on VOR radial 2400 and the distance travelled was about 26-28 nautical miles.

How were the aircraft parameters at rejoin?

At the rejoin for runway 27, we came in for ILS landing. All ILS indications were absolutely correct and matched quite well with both sides EFIS display.

What about the feel and touch-down?

The feel was almost like PT-I. The touch-down was almost around 90 knots. The nose-wheel was lowered at about 60 knots. The flight was extremely good.

What about the flight duration and the max.altitude reached?

We reached a max.altitude of 9200 feet, the aircraft on its first flight flew close to 45 minutes and the max.speed attained was about 150 knots.

Your final views on the first flight?

PT-II is a very graceful, potent and a powerful flying machine. As I descend down from the ASTE telemetry after the pilot de-brief, I realize that any first flight is a great challenge to mankind of his ever endearing skills, moments of supreme joy, 'hearts swelling with emotions of achievement', and eyes becoming moist with the pride of achievement.

R Guruprasad, Suju Thomas with Wg Cdr R S Makker

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“SARAS Gets More Power..”

#IP 764 7 - 13 May2007

The long awaited first flight of second SARAS prototype aircraft PT2 took place on Wednesday, 18 April 2007. The PT2 aircraft is powered by two PWC PT6A-67A engines of 1200 SHP each (compared to 850 SHP engine on PT1). The PT2 maiden flight was flown by Wg. Cdr. R S Makker, CTT-SARAS, Wg. Cdr. Arun Malik, Test Pilot-SARAS and Wg. Cdr. M S Ramamohan, FTE-SARAS of ASTE. The flight was successful and all the aircraft and engine parameters were normal. The total flight duration was about 45 min. The maximum altitude and speed reached were about 9000 ft. and 150 knots respectively. The take-off weight was close to 6100 kg.

The SARAS project team had been working very hard since mid 2006 to realise this event. The aircraft integration team had worked day and night without break to make the aircraft ready for the first flight. The actual countdown for the first flight of PT2 started on 23 March 2007 when the first low speed taxi trial was started after obtaining a clearance from the SARAS Flight Readiness and Review Board (FRRB) and the DGCA. Prior to this, about 16 engine ground runs had been carried out by the flight crew at NAL / ASTE. In all, 11 taxi trials were conducted before the first flight. Out of these 4 were low speed trials, 4 were high speed trials and finally, 3 more faultless SOP taxi trails were carried out successfully. The FRRB of SARAS PT2 conducted two full fledged meetings and two other small meetings before clearing the aircraft for the first flight. The DGCA officials took part in all these meetings and eventually, a go ahead was given for the first flight of PT2 on 17 April 2007.

There was an air of expectation among the SARAS team members on the ASTE tarmac on 18 April 2007 including the Director of NAL Dr. A R Upadhyaya. Air Cmde. M Matheswaran, VM, Commandant, ASTE, Air Marshal P. Rajkumar (Retd.), Chairman, FRRB, Prof. R Narasimha and Dr. T S Prahlad, Dr. B R Pai, Former Directors of NAL, DGCA officials and senior NAL staff members were also present on the occasion. The first flight test was directed by Wg. Cdr. P Ashoka (Retd.). Exactly at 8.35 AM on that day, the flight crew entered the cockpit and carried out successfully all the pre-flight checks and the aircraft taxied out of ASTE at 9.00 AM. The flight took-off at 9.05 AM after clearance by the ATC. The flight crew had conducted a detailed briefing for the first flight at ASTE on 17 April 2007. As there was enough fuel on board the flight crew extended the flight duration and carried out additional checks of the aircraft handling qualities and landed back at 9.50 AM.

The aircraft and the flight crew were warmly applauded on their return to the ASTE after the flight. Suddenly, a bottle of champagne appeared from nowhere and the occasion was celebrated with great jubilation. The SARAS flight crew and other team members were seen congratulating each other and patting on

each other's back. The first flight of PT2 is an important milestone in the SARAS aircraft development programme. There are many more such milestones that have are to be reached before certification of the aircraft. This is also an important event in the civil aircraft development programme of NAL.

M S Chidananda, Project Director-SARAS

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Technology Article – 1

#IP 790 5-11 Nov 2007

‘The Joy of Digital Video Compression’

The NAL Information Pasteboard carried an announcement that the Discovery Channel would be broadcasting the SARAS documentary under its ‘Planet Earth Comes to India – India Unleashed’ programme on 22/8/07 at 8:00 p.m. There was an urgent need to record this transmission.

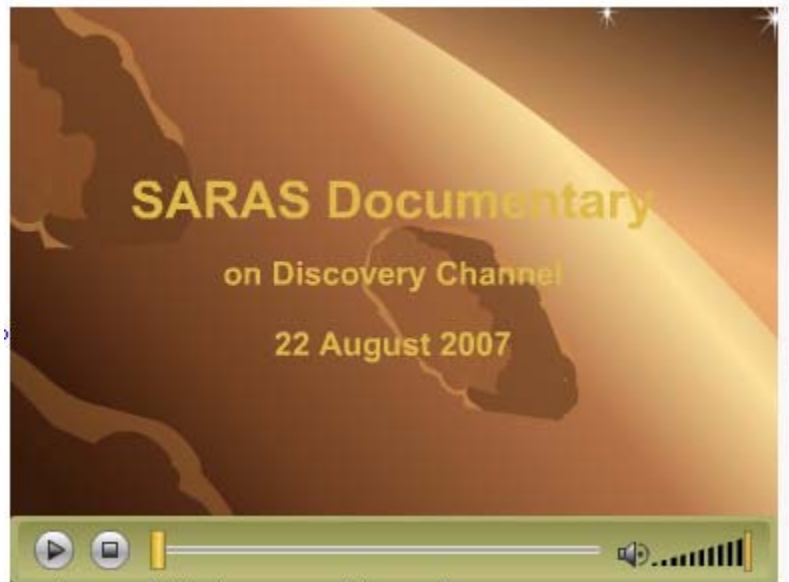
23rd August at the office was naturally hectic. First priority was to quickly digitize the recorded video onto the Non-Linear Video Editing Station (NLVES) and finally port the SARAS documentary on the NAL Home Page.

The road to host the SARAS transmission on the Home Page had its own ‘steep turns’. Here are some interesting moments:

- Re-dubbed the entire transmission to achieve an interpolated resolution of 800 TV lines from the VHS to the digital deck.
- Digitized the entire programme (5:21 minutes) onto the NLVES which resulted in a whopping 1.13 GB as an .avi file.
- For a DVD distribution, re-exported the 1.13 GB file (MPEG-2); the file size came down to 132 MB.
- A VCD version of the same brought it down to 53 MB.
- A Flash Video (FLV) format was thought off. Compression came down close to 16 MB.

Finally, using appropriate CODECS (compressors and decompressors), the VCD file was exported as a Flash .SWF file. File size came down to 11 MB at no quality loss.

Compressed video that was initially hosted on the web site was playing without any play controls to the end user. The end user needs play controls on the video clip to facilitate him in playing and controlling the video better. These are easily achievable through Flash Scripts and are a must when you host video on your web-site.



The road ahead is undoubtedly challenging. With sufficiently good bandwidth available now, and rapid advances in Flash technology, we need to go the 'Google' way in managing our 'digital content', (both static and dynamic).

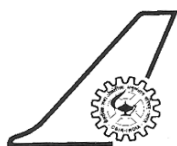
To recollect the old adage, that if "a picture is worth a thousand words", then it wouldn't be totally wrong to say that "a movie is worth a thousand pictures" in today's digital realm.



R Guruprasad

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Title: The SAGA of SARAS: Part-II (Report on Significant Events / Milestones Reached During the Making of SARAS Prototype -II and the Lessons Learnt from PT-I).

Period of Report: October 2006 to April 2007.

Author/s: +Ranjan Moodithaya, *KYegna Narayan, *MS Chidananda, +R Gururprasad and *Suju Thomas with technical articles from #Wing Commanders R S Makker, A Malik and M S Ramamohan. (+KTMD, NAL; *C-CADD, NAL and #ASTE, Bangalore)

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Keywords: SARAS Prototype PT-II, Multi-Role Light Transport Aircraft, Weight Optimization, P&WC 6A-67A of 1200 hp each, FAR-25, PT-II Inaugural Flight: 18 April 2007, Nacelle Modification.

Abstract: This NAL Project Document highlights the pioneering efforts made by the Centre for Civil Aircraft Design and Development in building the SARAS Prototype-II. SARAS Prototype-II, NAL's 14-seater light transport aircraft had its successful maiden flight on 18 April 2007 at 09:05 a.m. Several improvements have been incorporated in SARAS PT-II compared to the first prototype. Most important among these are the incorporation of higher power engines, P&WC 6A-67A of 1200 hp each and new propellers of larger diameter. The supporting stubwing structure and the engine nacelle have also been modified to suite the new engines. Added to this, significant improvements have been incorporated in the layout of flight control system, avionics and electrical systems. These improvements have brought PT-II much closer to the final production standard aircraft.

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