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Vice President Certification -
Deputy Senior Vice President
Quality and Certification
Signed by A. Gandolfo

«14» February 2017

SSJ chief designer- Deputy Vice
President on design, SCAC
Signed by V. N. Lavrov

«14» February 2017

Report
RRJ0000-RP-009-4241/B

Aircraft RRJ-95
Determination of operational limitation to satisfy local restrictions in average noise level to operate in Sweden, Stockholm Bromma (ESSB), airport.

February 2017

SCAC

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References

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ABBREVIATION LIST

A/C and a/c	Aircraft
AFM	Airplane Flight Manual
AFT	Aft C.G. position
AoA	Angle of Attach
APU	Auxiliary Power Unit
C.G.	Centre of Gravity
DGPS	Differential GPS
ECS	Environmental Control System
EPNL	Effective Perceived Noise Level
DECU	Full Authority Digital Electronic Control
FTI	Flight Test Instrumentation
FTP	Flight Test Program
FWD	Forward C.G. position
GPS	Global Positioning System
HP	Horse Power
Ht	Overhead Altitude
ICAO	International Civil Aviation Organization
ISA	International Standard Atmosphere
°K	Kelvin degree
LH	Left hand
L/G	Landing Gear
M	Mach number
MLW	Maximum Landing Weight
MTOW	Maximum Take Off Weight
NMLGD	New main landing gear door
NTO	Normal Take-off power
OAT	Operative aircraft Temperature
P3GS	Power for 3 degree Glide Slope
PwJ	PowerJet
NPD	Noise Power Distance curves
PNL	Perceived Noise Level
PNLT	Tone corrected Perceived Noise Level
RH	Right hand
S/L	Slant distance – microphone minimum distance from the trajectory path
S/N	Serial Number
S/W	Software
SL	Sea Level
SPL	Sound Pressure Level
TC	Type Certification
V_2	Climb-out Speed
Vref	Reference Landing Speed
Vs	Stall Speed

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INTRODUCTION

RRJ-95 (commercial name Sukhoi Superjet-100, SSJ-100) developed and produced by Sukhoi Civil Aircraft Company (SCAC) is a family of modern twin-jet regional class aircraft. Initial issue of EASA Type Certificate for first family member RRJ-95B was in 2012 (EASA TCDS No.EASA.IM.A.176). Approval of the subsequent model with increased MTOW RRJ-95LR-100 was achieved in December 2016. The aircraft are powered by two high By-Pass-Ratio engines SaM146 (two models are available, 1s17 and 1s18) developed and produced by PowerJet (PwJ) company. Initially the Engine Type Certificate has been issued by EASA in 2010. Community noise certification flight test has been done under EASA supervision in 2010 for RRJ-95B and in 2015 for RRJ-95B-100 and RRJ-95LR-100 models. Certification noise levels obtained during those flight test campaigns will be published on EASA TCDSN. In accordance with the Flight test results all RRJ-95 models comply with ICAO Annex 16 Volume 1 Chapter 4 noise limits.

This year fifteen RRJ-95 have been contracted by CityJet European airline company. CityJet have the intention to operate RRJ-95B-100 NMLGD with tow=43.5 t in Sweden, Stockholm Bromma (ESSB) airport where Stockholm city Consul applies local noise limits much more stringent than certification level. With the results achieved during our Flight test campaign the noise data level measured for the RRJ-95B, RRJ-95B-100 and RRJ-95LR-100 are not comply to that limits with MTOW and MLW. The intention of this report is to install dedicated operation TOW and LW limits to fulfill Stockholm City Consul special limitation for noise at Stockholm Bromma (ESSB) airport.

1. AIRCRAFT CONFIGURATION

1.1 Airplane Description

All models Russian Regional Jet named RRJ-95B, RRJ-95B-100 and RRJ-95LR-100, developed in Russia by SCAC are being certified on the Community Noise Certification campaign performed in Italy. The certification application was provided to the European Aviation Safety Agency EASA. The RRJ-95B /RRJ-95B-100/ RRJ-95LR-100 are aircraft with 98 passengers, turbofan Regional Jet aircraft equipped with two turbofan engines produced by Power Jet company named SaM146, for which a three view schema of the airplane and his main geometrical sizes is shown, for information, on figure 1.

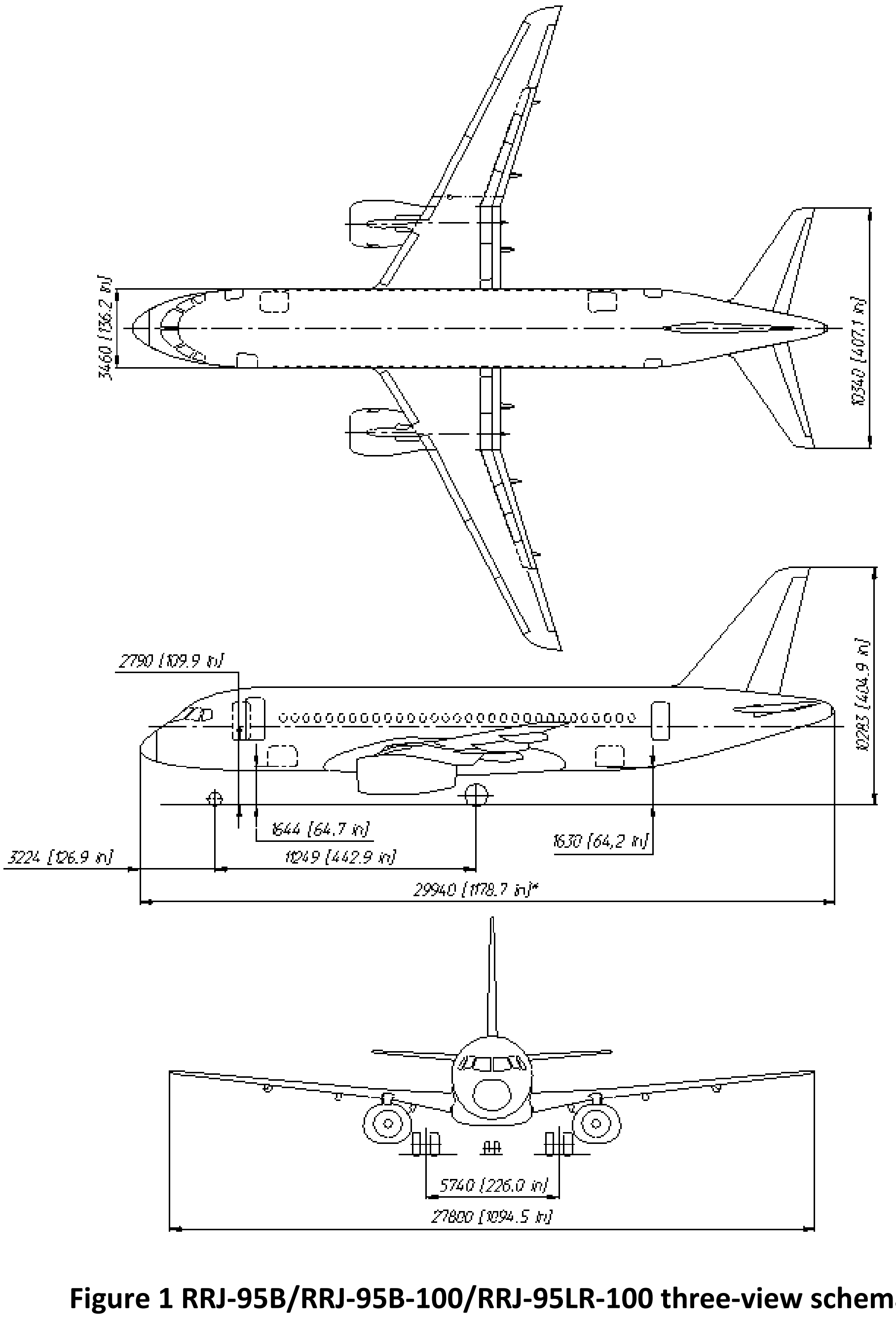


Figure 1 RRJ-95B/RRJ-95B-100/RRJ-95LR-100 three-view schema.

The main characteristics, in terms of weight of the RRJ-95B, RRJ-95B-100, RRJ-95LR-100 models are given on Table 1:

Aircraft Model	**RRJ-95B**	**RRJ-95B-100**	**RRJ-95LR-100**
Engine Model	**SaM146-1S17**	**SaM146-1S18**	**SaM146-1S18**
Weight performance			
Maximum take-off weight (MTOW)	45880 kg	45880 kg	49450 kg
	(101148 lbs)	(101148 lbs)	(109019 lbs)
Maximum landing weight (MLW)	41000 kg	41000 kg	41000 kg
	(90390 lbs)	(90390 lbs)	(90390 lbs)

Note: Green cells marked aircraft model selected for operation in Bromma (ESSB).

Table 1 RRJ-95B/ RRJ-95B-100 / RRJ-95LR-100 weight characteristics.

The airplane structure is composed of the following main parts:

Fuselage

The fuselage is of all-metal semi monocoque with stringers as longitudinal structural members, frames as lateral structural members and stressed skin.

The fuselage has a structural separation on 6 compartments: from F1 (Φ1) to F6 (Φ6).

The nose, aft-of-cockpit center and tail compartments of the fuselage compose the joint sealed compartment (pressurized cabin). The non-pressurized areas are the following compartments: nose wheel well, main landing gear bay, nose antennae compartment (radome) and APU compartment.

Wing

The RRJ-95B/RRJ-95LR-100/RRJ-95B-100 airplane have swept wing with span of 27500 mm, dihedral angle of 6˚ of tapered type with section brake at one third of the wing. The wing is configured with a supercritical airfoil.

The wing consists of LH and RH and outer parts of wing and center wing section.

Each of the outer parts of wing has a torsion box as the main load-carrying part, leading and aft parts, wing high-lift devices and control surfaces. The structural design of the outer parts of wing provides 4 attachment brackets of the pylon that has two engine mount assemblies.

The high-lift devices consist of inner and outer flaps, 4-section slat and 2-section air brakes.

The following control surfaces arranged on each part of the wing provide bank control: aileron and 3-section spoiler. Besides that the spoiler is used as an air-brake in flight and during landing, providing reduction of landing roll.

High-lift devices setting approved for operation for take-off and landing.

Table 2 provides the flap/slat settings used during take-off and landing according to EASA approved AFM M7.92.0AFM.000.000.EN for RRJ-95B/RRJ-95LR-100/RRJ-95B-100 models.

Flight phases	Flap lever position	Slats δ_{slats}	Flaps δ_{flaps}	V_{FE} (IAS) Speed
		Degree	Degree	km/h (kts)
Take-off	**«1 + F»**	**18**	**9**	389 (210)
Take-off	«2»	24	16	370 (200)
Approach/Landing	«3»	24	25	352 (190)
Approach/Landing	**«FULL»**	**24**	**36**	333 (180)

The configuration used during the noise certification testing: "1+F" at Take-off and "FULL" at Approach conditions are highlighted in **bold**.

Table 2 High-lift devices setting

Vertical Tail

The vertical stabilizer structurally is developed as a torsion box with leading edge and aft-of-spar part. The structure of the vertical stabilizer is composed by two spars, three LH and three RH panels and ribs.

Horizontal Tail

The horizontal stabilizer consists of LH and RH panels connected together along the aircraft center line. The horizontal tail is installed in the tail part of the fuselage. The stabilizer trimming to set angle is performed with a trimming actuator.

The elevator consists of LH and RH sections and is hinged on the horizontal stabilizer. Each of the sections is controlled with two hydraulic actuators.

Entrance doors, maintenance access and service doors and hatches

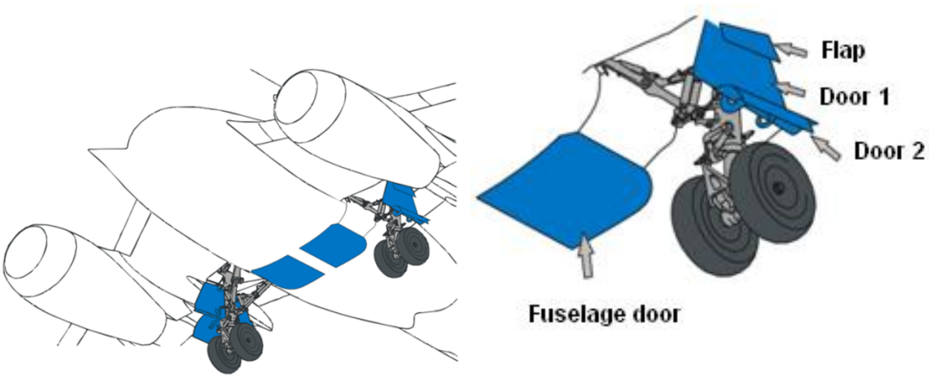
There are two crew and passengers entrance doors, two service doors and two doors of baggage-cargo compartments door as well as maintenance access doors in the pressurized part of the fuselage. The nose and main landing gear bays are closed with their corresponding doors.

Airborne systems:

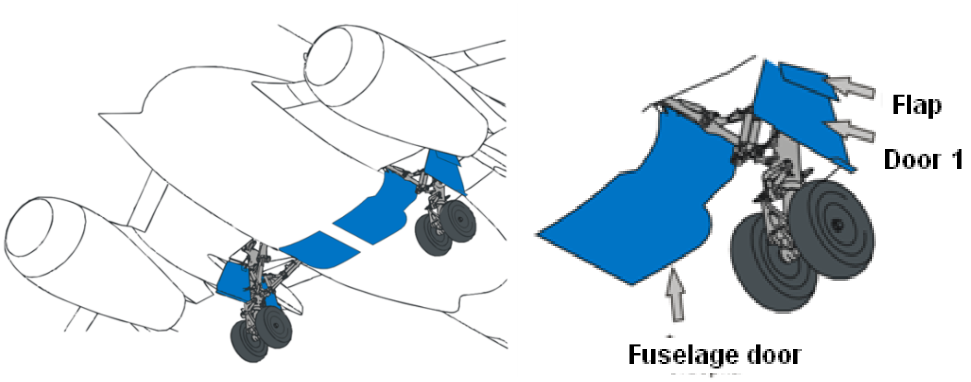
- Environmental conditioning system.
- Flight Control system.
- Electrical power supply system.
- Emergency (and survival) equipment.
- Fire Extinguishing system.
- Fuel system.
- Inert (neutral) gas system.
- Hydraulic system.
- Anti-icing protection system.
- Avionics.

- Landing gear. (Optional main landing gear door design available)

  To improve A/C take off performance and reduce the approach noise the Main Landing Gear Door (NMLGD) modification design has been developed and embedded in the Type design via TD MJC approval procedure. A/C delivered to CityJet company are fitted with that MCJ modification (for details see figure 2).



Initial design



Optional design

Figure 2 Optional landing gear design. Defined as ”New main landing gear doors” (NMLGD).

- Lights and warning system.
- Oxygen system.
- Water supply /waste disposal system.
- Flight compartment (cockpit).
- Passenger cabin.
- Cargo and accessory compartments.
- Airborne indicating and measuring system.

1.2 Power Plant System

The airplane power plant system has been developed by the PowerJet company and consists of two engines installed in the nacelles under the wings and pylons. It is possible to install the engine models SaM146-1S17 and SaM146-1S18.

The SaM146-1S17/SaM146-1S18 engines performance are defined in Table 3.

Thrust for Normal Take-Off ISA+15 at sea level (TCDS E.034)	6982 daN (15696 lbf)	7332 daN (16483 lbf)
Bypass ratio (NTO)	4.38	
Number of fan blades	24	
Fan diameter (m)	1.224	

Table 3 SaM146 engine main performance parameters.

1.2.1 Engine Description

The RRJ-95B / RRJ-95B-100 / RRJ-95LR-100 models are equipped with two PowerJet engines SaM146 developed in collaboration between SNECMA and NPO Saturn.

The SaM146-1S18 turbofan high bypass engine model (on figure 3) structurally does not differ from the earlier certified engine SaM146-1S17 excluding the identification plug that defines the engine thrust level.

This exhaust mixing engine has high bypass ratio (engine configuration (1+3)+6=1+3). The low-pressure duct has a fan and 3 add low-pressure stages that are driven by low-pressure turbine. The low-pressure turbine vanes have no cooling excepting the cooled vanes of the first stage.

The SaM146 fan has 24 scimitar-shape rotating blades. The low-pressure module has a bypass valves downstream of the 3rd-stage stator. High-pressure spool consists of a 6-stages axial flow compressor driven by a one-stage high-pressure turbine with an active gap control system.

The high-pressure compressor module has variable inlet guide vanes as well as variable inlet guide vanes on the first two stages. There is an annular combustion chamber with reverse-flow chamber and combustion diffuser.

There are two duct thrust reverser systems and exhaust mixing mounted on the engine.

The engine is controlled by DECU. Its architecture assures the maximum level of control reliability by effective use of system redundancy and malfunctions recording.

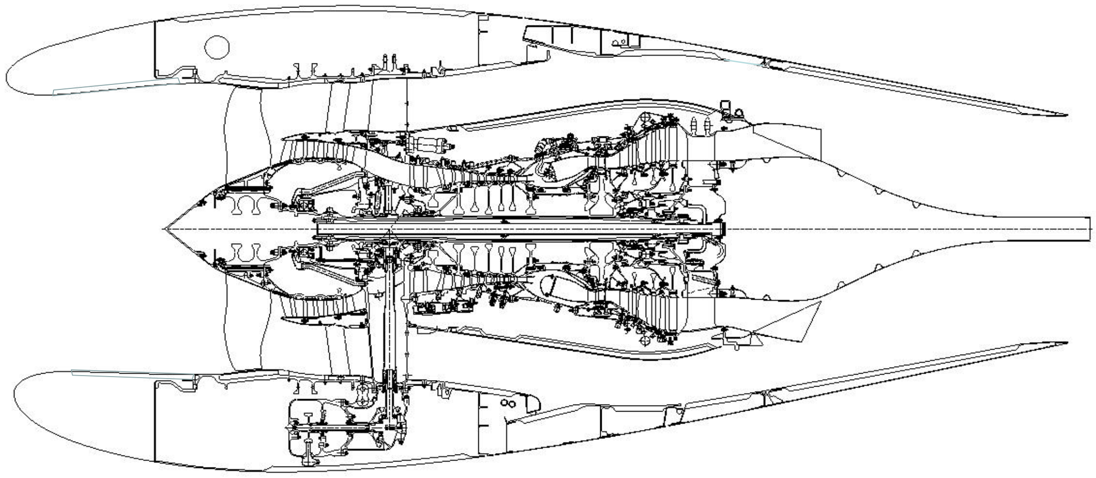


Figure 3 SaM-146 engine schema.

Engine / Nacelle

The engine nacelle is configured as a set of cowl panels composing integrated system and providing aerodynamic flow about the engine. The engine nacelle provides fire protection and lighting protection of the engine and equipment.

The engine nacelle consists of the air inlet (equipped with air inlet heated air anti-icing system), cowl panels of the fan, cowl panels of the thrust reverser (with movable thrust reverser doors), exhaust system (consisting of the central body, petal-type exhaust mixer and flow mixing nozzle).

Engine Noise Treatments

There are innovative technologies sound absorbing elements installed to provide decreasing of the engine noise levels. The internal surface of the air intake is developed as two-layered sound-absorbing punched panels with area of 1.6 m^2. Unlike the single-layered sound absorbing panels, it provides sound absorbing in wider range of frequency spectrum while there is no thickness rise of the structural elements at the air inlet compartment. There is a single-layered sound absorbing punched panel arranged in the inner surface of the mixing duct with the area of 6.7 m^2. The engine parts at the area of the gas generator (core) are provided with the additional two-layered sound-absorbing panels with area of 3.06 m^2.

There are nacelle areas with sound-absorbing panels shown on the Figure 4, and the information about sound-absorbing panels installed is provided in the Table 4. The details regarding installation of the sound-absorbing panels are shown on the Figure 5.

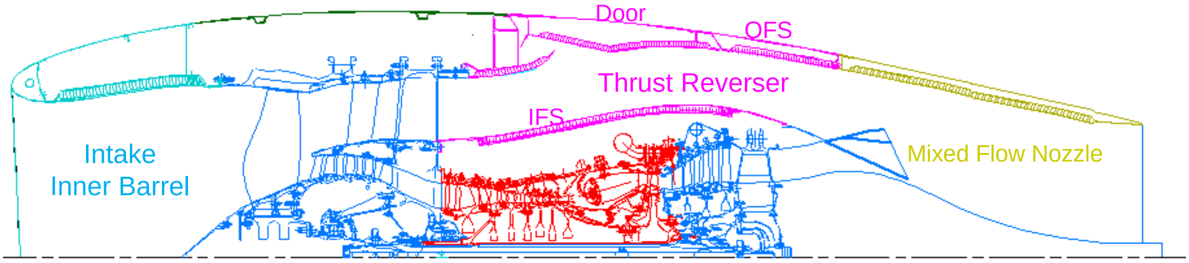


Figure 4 SaM146 Nacelle acoustic treatments

Acoustic areas	Area, m²
Intake Inner Barrel	1.52
Inner Fixed Structure	1.88
Ramp Fairings + Doors + Outer Fixed Structures	1.75
Mixed Flow Nozzle	3.06
TOTAL Aft Fan duct	6.69

Table 4 SaM146 engine noise treatment surfaces.

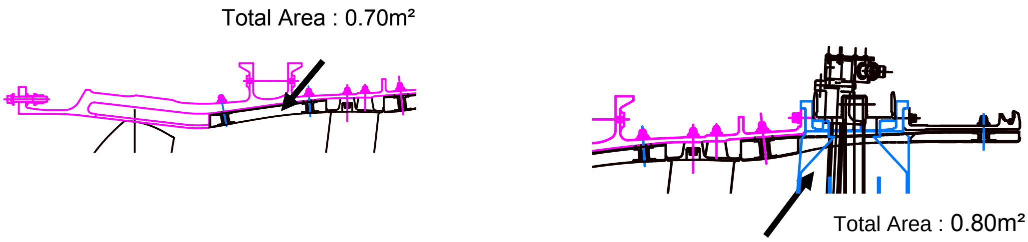


Figure 5 SaM 146 Fan frame acoustic panels.

1.3 Auxiliary power unit.

The aircraft is equipped with an APU RE220 [RJ] engine, manufactured by the Honeywell. The Auxiliary Power Unit (APU) provides generation of electrical power for the airborne electrical system, starting of the main engines and air supply to the environmental conditioning system. The APU engine is a constant speed single-shaft turbine engine. The APU is installed in the tail part of the airplane. The exhaust pipe is designed to reduce the noise. The APU has a Type Certificate №. CT 227-ВД (iss.2) issued on 03rd December 2005.

1.4 Certification Noise levels

The compliance of the RRJ-95B / RRJ-95B-100/ RRJ-95LR-100 models noise levels with Certification Basis requirements was demonstrated by means of data analysis results. Cumulative margin and any of two combined points margins versus certification limits and their Confidence Intervals are presented in Table 5.

The following table 6 provides the summary of results relevant for the RRJ-95 models:

- RRJ-95B equipped by two SaM146-1S17 engines,
- RRJ-95B-100 and RRJ-95LR-100 models equipped by two SaM146-1S18 engines.

Model	**Flight Condition**	**MGWT** [Kg] [lbs]	**LATERAL** [EPN dB]	**FLYOVER** [EPN dB]	**APPROACH** [EPN dB]	***Sum of Margins to CS36 - ICAO Annex 16, Chapter 3 limits Minimum sum of margins at any two conditions***
RRJ-95B	**TAKEOFF**	**45880** [101148]	**90.9** **(- 4.1)** **CI90 = 0.3**	**82.9** **(- 6.1)** **CI90 = 0.2**		***14.8 EPNdB (-10.0 EPNdB)***
	APPROACH	**41000** [90389]			**94.3** **(- 4.6)** **CI90 = 0.2**	***8.7 EPNdB (≥2.0 EPNdB).***
RRJ-95B-100	**TAKEOFF**	**45880** [101148]	**93.5** **(- 1.5)** **CI90 = ±0.268**	**82.1** **(- 6.9)** **CI90 = ±0.187**		***14.3 EPNdB (□ 10.0 EPNdB)***
	APPROACH	**41000** [90389]			**93.0** **(- 5.9)** **CI90 = ±0.285**	***7.4 EPNdB (≥2.0 EPNdB).***
RRJ-95LR-100	**TAKEOFF**	**49450** [109019]	**93.5** **(- 1.8) CI90 = ±0.322**	**84.5** **(- 4.7)** **CI90 = ±0.247**		***12.7 EPNdB (□ 10.0 EPNdB)***
	APPROACH	**41000** [90389]			**93.0** **(- 6.2)** **CI90 = ±0.270**	***6.5 EPNdB (≥2.0 EPNdB).***

Note: Green cells marked aircraft model selected for operation in Bromma (ESSB).

Table 5 Noise certification values for RRJ-95B, RRJ-95B-100, RRJ-95LR-100 models.

2. LOCAL NOISE LEVEL LIMITS

2.1 Local aerodrome restrictions. Bromma (ESSB), Sweden, Stockholm.

The noise emission must not exceed 89 EPNdB, as an average for the three points of measurement in accordance with ICAO Annex 16 Vol I Chapter 3. Special rules concerning schedule air transport issued by Airport manager.

3.1.1 Operators wanting to apply for special procedure to lower their noise emissions in order to operate within the limits above must seek permission addressed to the aerodrome manager in writing or in special cases by phone. The request shall include relevant information on type and model of the aircraft and engines, MTOW and an exact description of the suggested procedure. The matter can be handled during office hours only.

Note 1: Detailed provisions for the use of Bromma aerodrome are published in Regulations to Civil Aviation BCL A 5.

Aircraft used for scheduled service shall,

- either be certified for noise emission which does not exceed 86 EPNdB as an average for the three measuring points in accordance with ICAO Annex 16 Volume I, Part 2, Chapter 3,

- or be able to operate at the airport not exceeding 86 EPNdB for the three measuring points in accordance with ICAO Annex 16, Volume I, Part 2, Chapter 3.

- however 20000 annual movements are permitted to be operated by subsonic jet aircraft with a seating capacity exceeding 60 seats with a noise emission which exceeds 86 but not 89 EPNdB as an average for the three measuring points in accordance with ICAO Annex 16, Volume I, Part 2, Chapter 3. The number of such operations on Saturdays and Sundays may not exceed the number of such operations during 2001.

2.2 Compliance demonstration for RRJ-95B-100 NMLGD.

In accordance with the certification flight test campaign results as described previously the models RRJ-95B and RRJ-95B-100 and RRJ-95LR-100 comply to ICAO Annex 16 Volume I, Part 2, Chapter 4 noise limits, but they do not comply with the local Stockholm Bromma ESSB airport requirements. By installation of dedicated TOW and LW limits the RRJ-95B-100 NMLDG fulfill the Stockholm Bromma ESSB airport noise requirements. Substantiation of the effect of TOW limits is given in Chapter 6 of this report.

TOW kg	LW, kg	A/C model	Sideline	Flyover	Approach	Average value	Delta with Bromma limitation value 89 EPNdB
			SL EPNdB	FO EPNdB	AP EPNdB		
45880	41000	RRJ-95B	90.9	82.9	94.3	89.37	0.37
45880	41000	RRJ-95B-100 NMLGD	93.5	82.1	93.0	89.53	0.53
43500	41000	RRJ-95B-100 NMLGD	**93.5**	**80.5**	**93.0**	**89.0**	**0.0**

Note: Green cells marked aircraft model for using in Bromma (ESSB).

Table 6 RRJ-95 models certification values comparison with the local aerodrome restrictions in ESSB - Bromma.

3. Determination of the new TOW limit for RRJ-95B-100 NMLGD to fulfill ESSB Bromma noise limitation.

3.1 New TOW for RRJ-95B-100 NMLGD.

Aircraft Model	RRJ-95B-100 NMLGD
Weight performance	
Take-off weight (TOW)	43500 kg (95901 lbs)
Landing weight (LW)	41000 kg (90389 lbs)

Table 7 Weight limits.

3.2 Reference trajectory.

Performance calculations of RRJ-95B-100 with the NMLGD and the new TOW 43500kg have been performed by using a SCAC computer program. That program is verified and validated with the certification flight test data and is used for Performance computation for Airplane Flight Manual.

In this paragraph the calculated take off reference trajectory print out and the relevant charts are reported. They have been computed according to ICAO Appendix 16 Chapter 4, FAR 36 Section B36 IAC AR AR-36 points. All the of aforementioned requirements are harmonized from the point of view of the trajectory definition:

The reference procedures have been determined for the following reference conditions:

1. Sea level atmospheric pressure of 2116 pounds per square foot (psf) (1013.25 hPa);
2. Ambient sea-level air temperature of 77 °F (25 °C, i.e. ISA+10 °C);
3. Relative humidity of 70 per cent;
4. Zero wind.

3.2.1 The takeoff reference flight path

The take-off reference flight path is calculated using the following operational conditions:

1. “Worst” engine take-off thrust (NTO rating) is used from the start of take off to the end of trajectory calculation. The dependency of engine thrust vs. Mach, Altitude and Temperature is used accordingly to the SaM-146 Engine computer deck supplied by PowerJet.
2. Upon reaching the height specified above, the airplane thrust has not been reduced below that required to maintain level flight with one engine inoperative since it is greater than the alternative climb gradient of 4% with both engine operative.

3. The take off reference speed is with all-engine operating take off climb speed selected for use in normal operation; this speed is within the range of $(V_2+10kt)<V<(V_2+20kt)$. This speed is attained as soon as practicable after lift-off and maintained throughout all the take off noise certification test.
4. The take off FLAP setting configuration is maintained constant throughout the take off reference procedure, except that the landing gear is retracted after lift-off.
5. The weight of the airplane at the brake release is the new take off weight equal to 43500 kg.
6. The average engine is defined as the average of all the certification compliant engines used during the airplane flight tests campaign, up to and during certification, when operating within the limitations and according to the procedures given in the relevant Airplane Flight Manual. This will determine the relationship of thrust to control parameters

The Lateral reference flight path has been calculated using the following considerations applicable to RRJ-95B-100 NMLGD with new MTOW definition:

- The airplane is stabilized on a 10.95° climb path;
- A steady climb speed of 169 KCAS equal to $(V_2+10kt) < V_{35ft} < (V_2+20kt)$) with thrust and power stabilized is maintained over the sideline measuring point. V_2 is the reference take-off speed, which is defined as the speed of the airplane, in the take-off configuration, at the point where it climbs over the reference overhead altitude point.
- The constant take off configuration used in the airworthiness certification tests with the landing gear up, is maintained throughout the take-off reference procedure, just after the retraction coming as soon as possible after the lift-off;
- The weight of the airplane at take-off is the maximum weight permitted in the configuration equal to 43500 kg.
- APU in OFF and air bleed condition OFF condition,
- Medium CG position =30%.

The parameter $N1\%/\sqrt{\Theta_{t2}}$ is calculated using the program DECA ref. [6].
The overhead altitude at maximum sideline noise location as experimentally defined is similar for both model RRJ-95LR-100/ RRJ-95B-100.
For the certification Lateral noise position the following calculated main parameters are defining the Reference Trajectory conditions in table 8.

MTOW (kg)	**Altitude** (ft)	**KCAS** (kt)	**KTAS** (kt)	**Total Thrust** (kg)	**N1%/$\sqrt{\Theta_{t2}}$**
RRJ-95B-100 NMLGD 43500	1042	169.0	174.6	2 x 5831	93.5
Certified RRJ-95B-100 45880	1042	167.3	173.3	2 x 5840	93.5

Table 8 RRJ-95B-100/RRJ-95B-100 NMLGD with TOW limit of 43.5 tons Takeoff Reference Trajectory parameters.

3.2.2 Spool down test results

The flight test activity was performed on the prototype aircraft N.95032 being an approved type design as well as PPS configuration for the Community noise test (two Engines SaM 146-1S18 (S/Ns SaM146153, SaM146155) with FADEC S/W version 5.1) to verify the spool-down time from Take-off power setting to cut-back thrust and other thrust setting at different airspeeds and altitudes. The data were collected during the flight tests №148,151 (05.11.2015, 12.11.2015).

The spool down time (average between left and right engine) relevant for the thrust reduction from the NTO (N1=92.2%) down to the selected for the reduced power flyover condition (N1=77.7%) is 2.2 sec.

The spool down time (average between left and right engine) relevant for the thrust reduction from the NTO down to the selected for the reduced power flyover condition is described by the equation: Y= -10.704X+101.55 (s) on figure 6.

The following is a summary of the data obtained:

mode	Target Fan speed rotation N1 (%) after spool-down	KCAS	Altitude (ft)	Spool-down Time of Left Engine 153 (sec)	In flight test N1 (%) of Left Engine 153	KCAS	Altitude (ft)	Spool-down Time of Right Engine 155 (sec)	In flight test N1 (%) of Right Engine 155	Average Time of left and right Engines (sec)
601	85	175	3025	1,6	85,8	178	3006	1,6	84,6	1,6
601	85	182	3033	1,6	84,5	171	3010	1,6	84,9	1,6
601	85	178	3035	1,5	84,8	178	3015	1,4	86,7	1,45
601	85	175	3020	1,6	85,3	-	-	-	-	-
601	85	180	3019	1,5	85,0	-	-	-	-	-
602	80	176	3415	2,2	80,8	177	3396	2,0	80,6	2,1
602	80	178	3406	2,0	79,8	175	3413	2,1	80,0	2,05
602	80	178	3413	1,9	79,8	176	3411	2,1	79,8	2
603	79.3	179	3013	2,0	80,2	178	3010	2,0	78,5	2
603	79.3	177	2980	2,1	78,9	175	3016	2,0	78,6	2,05
603	79,3	177	3002	2,1	79,6	177	3014	2,1	78,8	2,1
603	79,3	175	3003	2,0	78,7	177	3007	2,1	78,8	2,05
604	77,2	181	3399	2,4	77,2	175	3383	2,2	76,9	2,3
604	77,2	180	3389	2,3	77,3	180	3417	2,4	76,1	2,35
604	77,2	178	3396	2,4	77,2	181	3422	2,3	76,9	2,35
605	75	177	2999	2,4	75,4	178	2999	2,5	74,3	2,45
605	75	175	3000	2,5	74,9	176	3012	2,5	75,2	2,5
605	75	176	3001	2,5	75,8	175	3015	2,5	74,3	2,5
605	75	176	2988	2,4	75,7	179	2995	2,5	74,4	2,45
605	75	-	-	-	-	179	2997	2,4	75,0	-
606	70	176	3004	2,9	69,4	178	2997	3,0	69,0	2,95
606	70	175	3002	3,1	69,8	175	3005	2,9	69,6	3

Table 9 Spool down test results SaM146-1S18

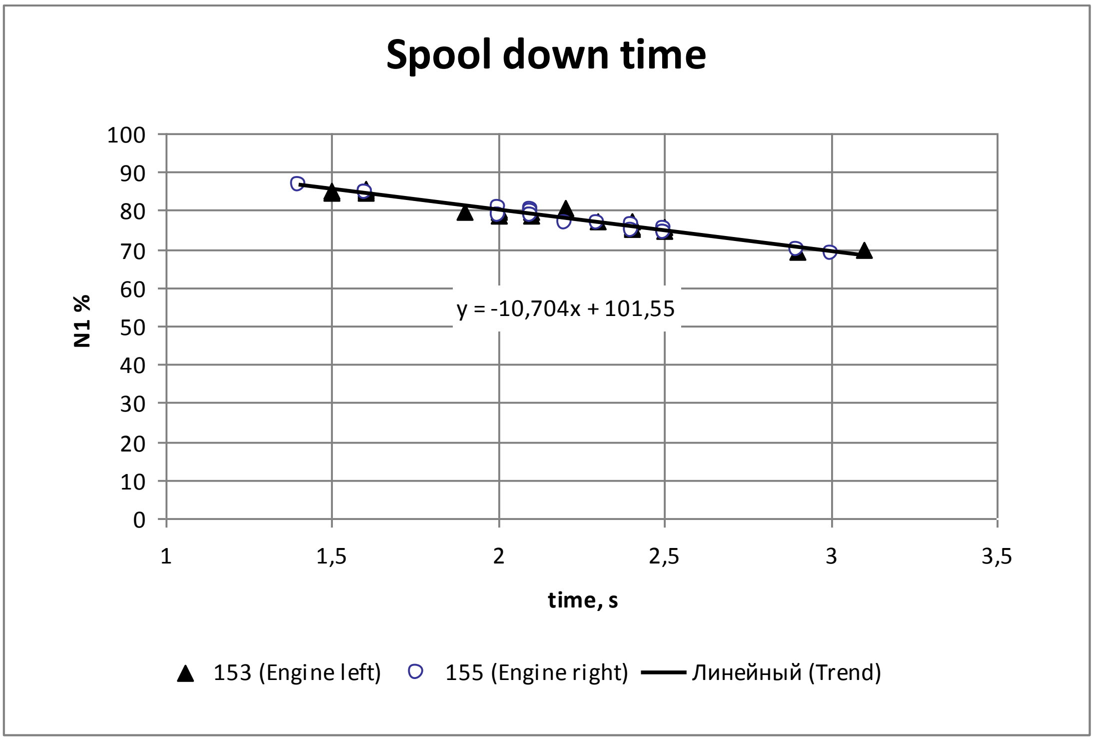


Figure 6 Spool down time.

3.2.3 Cutback trajectory flight path

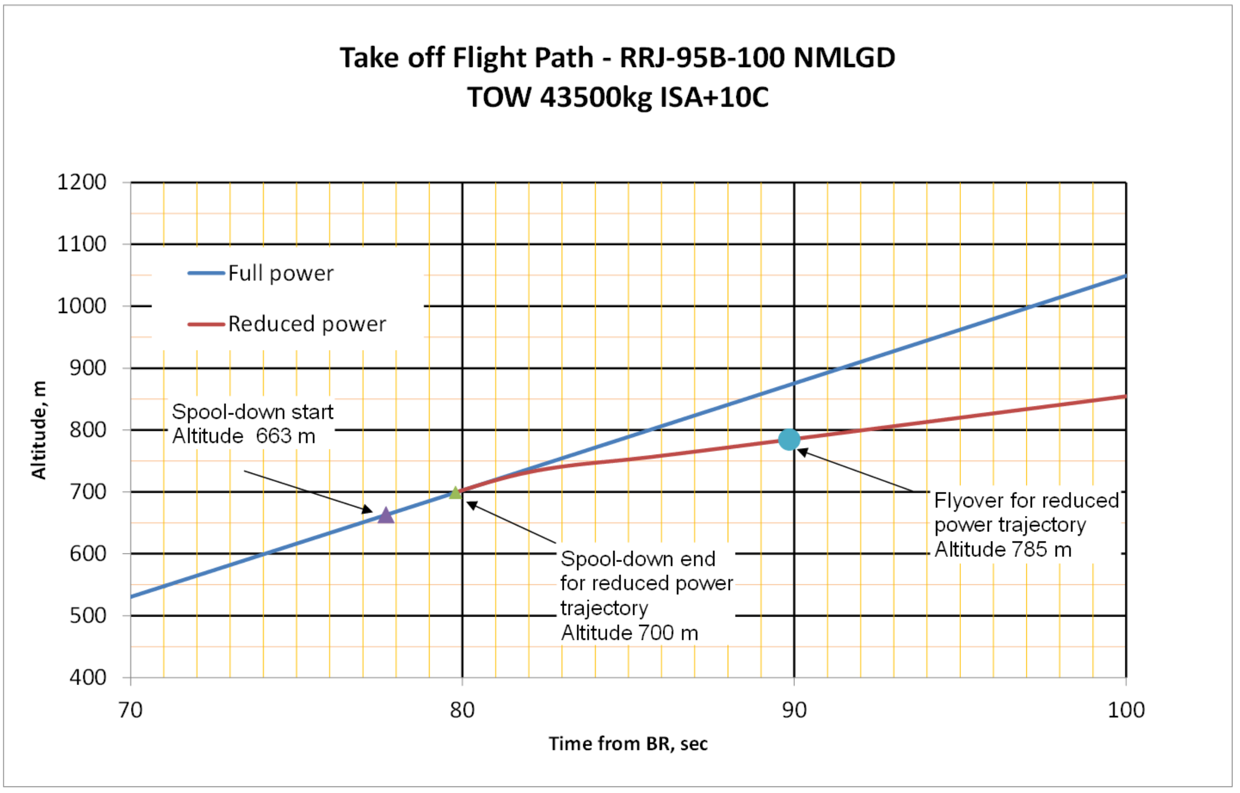
The criteria used to define the cutback path are the following:

The starting thrust reduction point on the full power trajectory path is selected as the lower possible to assure that the PNLTmax-10.5 dB relative to the noise time history measured on ground at the reference certification point located 6500m from the brake release, still lies on the stabilized reduced flight path segment, therefore the transient segment must not be included in the calculation of the EPNL for the Flyover condition.

The cutback altitude definition has been verified and updated by means of data analysis performed on several certification runs flown at thrust close to the reduced thrust condition. To get reliable values of the optimized trajectory parameters the average result of the tested runs has been calculated, hereafter the main results are given.

The optimized flyover trajectory calculation provides a cutback starting altitude of 2240 ft and an altitude over the reference flyover location (6500 m from the brake release) of 2575 ft on figure 7.

The parameter $N1\%/\sqrt{\Theta_{t2}}$ is calculated using the program DECA ref. [6].



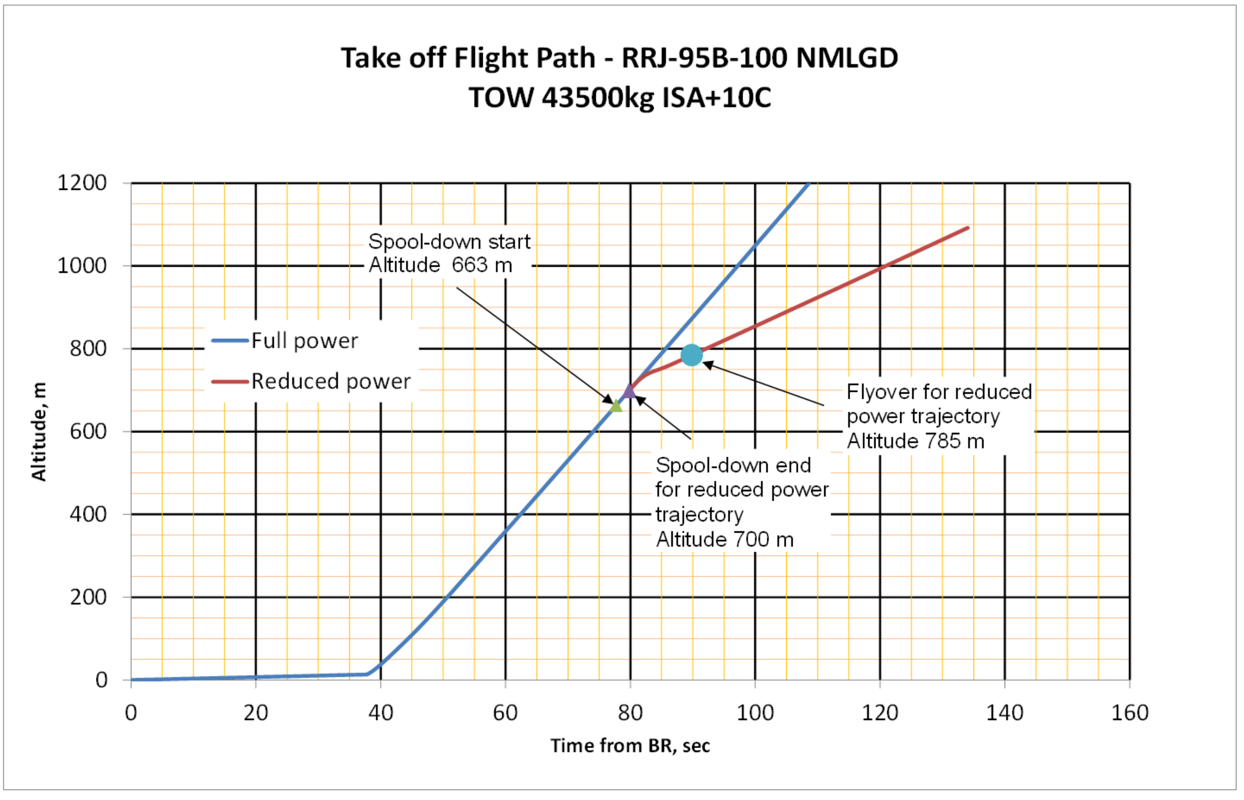


Figure 7 RRJ-95B-100 NMLGD TOW limit=43.5tons, Full power Take-off and flyover Cut-back reference trajectories

Table 10 reports the calculated main parameters relevant for the Flyover position RRJ-95B-100 MLGD Certification Reference Trajectory (45.8 t) and the Reference Trajectory for (43.5 t).

MTOW (kg)	Altitude (ft)	KCAS (kt)	KTAS (kt)	Total Thrust (kg)	N1%/√Θ_{t2}
RRJ-95B-100 MLGD 43500	2575	169.0	178.8	2 x 3326.5	76.4
RRJ-95B-100 MLGD 45880	2263	166.7	175.4	2 x 3595	78.6

Note: -FO altitude as defined for certification noise level. Original reference trajectory has been down shifted to satisfy PNLTmax-10,5 dB interval requirement.

Table 10 RRJ-95B-100 /RRJ-95B-100 NMLGD with TOW limit of 43.5 tons Flyover Reference Trajectory parameters.

3.2.4 Approach reference flight path

In this paragraph calculated approach reference data are reported. They have been computed according to FAR 36 Section B36 points (or equivalent CS rule section as applicable).

According to the ICAO Annex 16 requirements, the reference procedures have been determined for the following reference conditions.

The approach reference flight paths are calculated using the following:

1. The airplane configuration is stabilized and following a 3.0° glide path;
2. A steady approach speed equal to (V_{REF}+10 kt) with thrust and power stabilized is maintained over the whole approach measuring path. V_{REF} is the reference landing speed, which is defined according the RRJ-95 CB STCRRJ-CS25.125 and CS-25 25.125 requirements for determination of the landing distance for manual landings.
3. The constant approach configuration used in the airworthiness certification tests, with the landing gear down, is maintained throughout the approach reference procedure;
4. The weight of the airplane at touchdown is the maximum landing weight permitted in the approach configuration equal to 41000 kg. APU in OFF and air bleed condition ON condition.
5. Forward CG position.

Summary of calculation conditions for the RRJ-95B-100 NMLGD:

- Landing Reference speed V_{REF} + 10 kt = 159.8 KCAS - (Where V_{REF} complies with RRJ-95B-100 NMLGD performance)
- The parameter $N1\%/\sqrt{\Theta t_2}$ is calculated using the program DECA ref. [6].

Table 11 reports the main parameters relevant for the Approach certification position as defined by the Reference Trajectory conditions for RRJ-95B-100 NMLGD.

MLW (kg)	Altitude (ft)	KCAS (kt)	KTAS (kt)	Slope (dgr)	Total Thrust (kg)	$N1\%/\sqrt{\Theta_{t2}}$
RRJ-95B-100 NMLGD 41000	394	159.8	154.4	-3°	2 X 1350	54.8
Certified RRJ-95B-100 41000	394	159.8	154.4	-3°	2 X 1350	54.8

Table 11 Approach Reference Trajectory parameters RRJ-95B-100 NMLGD.

4. DATA SOURCE AND REDUCTION PROCEDURES

4.1 Flight test program and Test Aircraft description

The Special Certification Factory Flight Tests on measuring of the community noise levels were conducted flying the model RRJ-95B aircraft MSN.95004/Reg:97007 since 15th September 2010 till 23rd September 2010 at the airports Caselle (Turin, Italy) and Levaldigi (Cuneo, Italy) [Ref.1]. The flights were performed in compliance with the Certification Factory Tests No. RRJ 95-130-042-СЗИ Program, approved by Vice-President for Design - Chief Design for SSJ Program on 11th October 2009 and validated by IAC AR on 17th December 2009 and EASA.

The Sukhoi models RRJ-95LR-100/RRJ-95B-100 aircraft MCN.95032/Reg.97006 have been tested in flight to demonstrate the compliance to the RRJ-95 Basis of Certification making reference to both CS36 certification rules and, providing the equivalent requirements. The flight activity has been implemented in accordance with the Flight Test Program issued for approval to EASA (referred in the following only as Authority).

The Additional Certification Flight Tests on measuring of the community noise levels were conducted flying the RRJ-95LR-100/ RRJ-95B-100 airplane No. 95032 since 4th November 2015 till 12th of November 2015 at the Caselle (Turin, Italy) and Levaldigi (Cuneo, Italy) airports [Ref. 2,3].

The flights were performed in compliance with the Program of the Additional Certification Flight Tests No. RRJ 95-130-143-DCI rev. 3, approved by SSJ Program Chief Designer and SCAC President and EASA on 3rd October 2015.

Figure 8 show a photo of the aircraft used during the Community Noise flight test activities.

Figure 8 RRJ-95B (MSN95004/reg. 97004 upper photo), and RRJ-95B-100/RRJ-95LR-100 (MSN95032/reg. 97004 bottom photo) used for noise test campaign.

Certification flight tests have been performed at Finmeccanica (hereinafter simply referred as Alenia Aermacchi, Alenia Aeronautica, Alenia) facility in Levaldigi

(Cuneo, Italy airport) with the contribution of Alenia experts, in the same way as performed in the 2010 RRJ-95B CN Certification campaign, and to the SCAC/Alenia work share definition. For an easy understanding of the following work discussion, hereafter Alenia and SCAC agreed the responsibility share to conduct the noise certification tests as summarized herein:

- SCAC, was responsible for the certification activity toward the Authorities, in particular has assured the aircraft flight activity, including the on-board measurements of the aircraft flight parameters by means of its own on-board FTI. The contact and all the documentation flow from and to the Authority were managed by SCAC Certification department.
- Alenia has proposed the Flight Test Plan, provided the telemetry system and the real time monitoring of the aircraft flight parameters, performed the noise tests, analyzed data and prepared the draft of Compliance Report, by means of its own capabilities including facilities, instrumentation, process and expertise's.

The Alenia equipment/procedures used during the RRJ-95 models noise flight tests campaign, the expertise and the data analysis methods to carry out the test campaign from the Flight Test Plan up to the Compliance to Certification Requirements report preparation have been verified and approved by EASA.

The noise levels ground measurements were performed by personnel of Alenia Aermacchi (Italy) together with inspections of EASA aviation authorities.

The conducted tests allowed to evaluate the airplane community noise levels, and to define their compliance with the environmental requirements stated in the Section 3 (i.3.1 Requirements to community noise) of the RRJ 95/75 airplane Certification Basis.

The Finmeccanica "Community Noise Data Reduction" procedure has been applied to analyze the RRJ-95B/ RRJ-95B-100 measured data. This procedure has been developed fully in agreement with the ICAO Annex 16, volume I, chapter 3 and 4 and relevant instructions given by the ICAO Technical Manual doc. 9501 and FAA AC-46C, inspected and approved by EASA in 2010.

In the following paragraph the most relevant information of this Reduction Process are reported making reference to the approved procedure and to the relevant ICAO Annex 16 and/or related Technical Manual reference paragraphs describing the applied methods.

This Finmeccanica proprietary data reduction and analysis process used to analyze the RRJ-95B/RRJ-95B-100 certification data is a complex process which includes:

- **data download:** digitalization of recorded data and preparation of input for the pre-analysis and subsequently for the post-analysis;
- **data check:** performed to select the good data, identify the bad runs and relevant justification for their rejection;
- **software code input files preparation:** for the analysis code implementing the main analysis process, made by means of pre-process procedure/codes;
- **main code:** running to calculate test and reference EPNL values plus other indexes;
- **post-processing:** - data to calculate: NPD curves, Interval of confidence;
- **compliance demonstration:** - calculation of certification levels.

4.2 Data Digitations Process

4.2.1 Calculation of Test and Reference EPNL

ICAO Annex 16, Appendix II recommended calculation procedures were used to calculate the Effective perceived Noise levels (EPNL), in particular for each 0.5 sec. spectra, a perceived noise level (PNL) was determined based upon procedure given within Chapter 4.2. Tone corrected (PNLT) values were calculated per Chapter 4.3. PNLTM is calculated per Chapter 4.4.

A duration correction, D, based upon integration of the PNLT values within 10 dB of the maximum, PNLTM, is calculated per Chapter 4.5. The noise value, EPNL, was calculated from the sum of the PNLTM and the duration correction, D, per Chapter 4.6. [*Ref. ICAO Annex 16, Appendix II, Chapter 4*]

Corrected test-day (EPNLT) and ICAO reference-day (EPNLR) were calculated for both ICAO recommended “Simplified” and “Integrated” procedures. Alenia Software code implementing the methodology has been approved for both procedures in accordance with ICAO Annex 16 and FAR36 requirements. [*Ref. ICAO Annex 16, Appendix II, Chapter 9.3 – .9.4*]

In particular:

1. Adjustments to reference conditions using “Simplified Procedures” are given by: *[Ref. ICAO Annex 16, Appendix I, Chapt. 9.3]*

EPNLR = EPNLT + Δ1 + Δ2 + ΔS + ΔP + ΔH

Where: EPNLR = Reference NPD EPNL value

EPNLT = Test-Day EPNL

Δ1 = PNLTMTest – PNLTMRef

Δ2 = -7.5 Log10 (Rtest/Rref)

ΔS = +10 Log10 (Vtest / Vref)

ΔP = Correction for Multiple Peaks

ΔH = Correction to maximum S/L and test Ht

Rtest = Test-Day Minimum distance to the flight path

Rref = Reference minimum distance to flight path

αtest = Absorption coef, defined per ARP866A, test-day, T, RH

αref = Absorption coef, defined per ARP866A, ref-day, 77°F, 70% RH

Vtest = Test groundspeed, kt

Vref = Reference groundspeed, kt

Adjustments to reference conditions using “Integrated Procedures” were done as defined in ICAO Annex 16, Appendix II. Each 0.5-sec. spectrum is adjusted to the reference path length based upon equal propagation angles,

$$SPL(i)r = SPL(i) + 0.01\,[\alpha(i)\,test - \alpha(i)ref]\,Rtest + 0.01\,\alpha(i)ref\,[Rtest - Rref] + 20\,log(Rtest\,/\!-\,Rref)$$

2. Then the final reference EPNL is calculated by summing the integration of the respective adjusted PNLT vs. time in the 10 dB down interval (Duration Correction) to the PNLTM.

[Ref. Capt. 9.4]

Calculation of NPDs curves

Lateral, Flyover and Approach NPDs curves are defined by either a 1st or 2nd order regression curve of the respective EPNLR values as a function of the average referred engine fan speed, $N1\%/\sqrt{\Theta_{t2}}$ The parameter $N1\%/\sqrt{\Theta_{t2}}$ are calculated using the program DECA ref. [6].

An Alenia proprietary Matlab code was programmed to provide 1st, 2nd and 3rd order mean line regression equations in addition to a k+1 order regression for the 90% Confidence Interval distributed about a mean line regression of order k. The implemented methodology is compliant to the recommendation given within ICAO TM doc. 9501, Appendix 1, and it is included within the EASA approved analysis procedure.

[Ref. Capt. 5.4 – TM doc.9501]

Calculation of reference height for Lateral NPD curves

The reference overhead height for the NPD Lateral condition was defined during the preliminary analysis performed during the test, by means of the following procedure based on ICAO recommendation given within the TM doc. 9101, chapter 2.3.1, and approved by EASA. This reference altitude is defined as the altitude of the aircraft when the maximum noise occurs on both side parallel lines 450-m from the flight truck (sideline measurement locations), while aircraft is flying along the full power trajectory segment after the takeoff. This maximum was experimentally searched by means of several test runs flown at different overhead altitudes from 500 ft to 1900 ft of altitude (100-series runs). Then the corrected EPNL values for each side were plotted against the relevant altitude; the averaged EPNL for each S1-S2 couple was calculated then the 2nd order regression equation were derived for the averaged sideline data pool, the maximum of this curve defines the Lateral reference overhead altitude.

[*Ref. TM doc. 9501, chapt. 2.3.1*]

Definition of the Lateral overhead altitude was performed during the test campaign RRJ-95B-100/RRJ-95LR-100 campaign ref.[2]

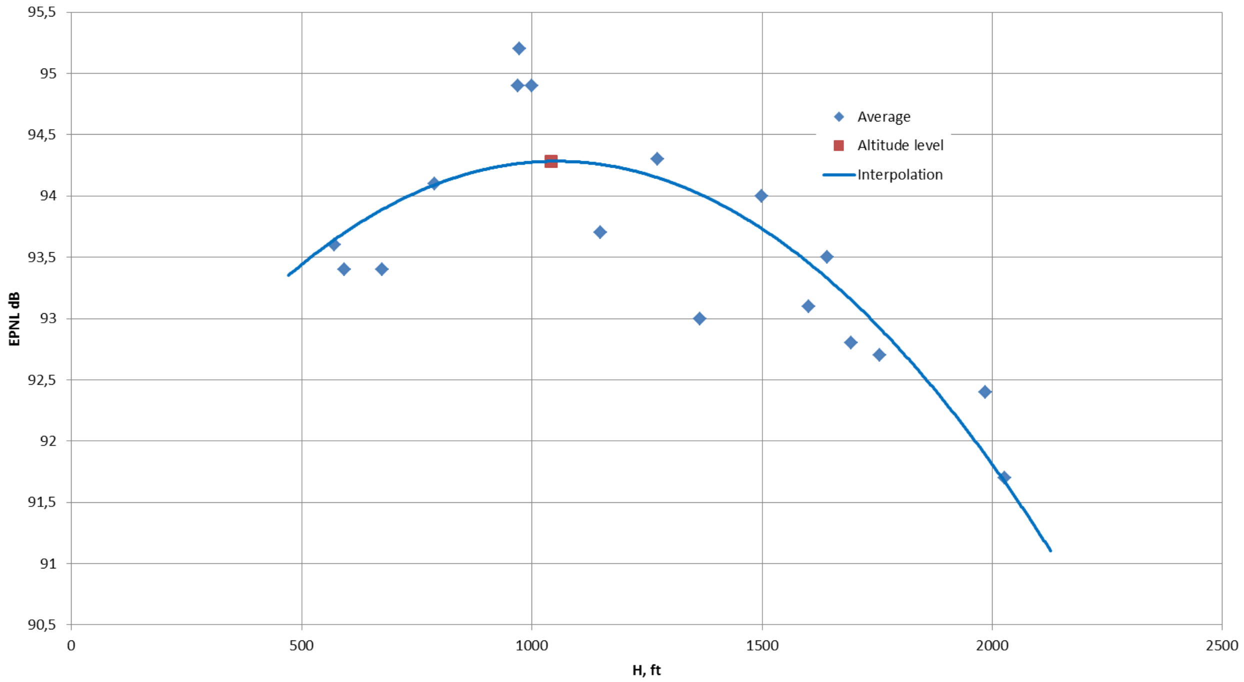


Figure 9 Sideline Overhead altitude definition for RRJ-95B-100 with Sam146 1s18.

The results **RRJ-95B-100** tests analysis show graphically on figure 9 and these data and the resulting regression equation:

EPNLC = a h^2 + b h + c

Where: h is the aircraft overhead altitude, and

a = -2.07887 10^{-6}; b = 4.33192 10^{-3}; c = 91. 67063

The lateral reference altitude is then derived from the maximum of the equation:

hmax= -b/2a

The resulting altitude is: hmax = 1042 ft.

4.2.2 Calculation of Certification levels

The Certification Noise levels relevant for the RRJ-95B/RRJ-95B-100 models at reference Lateral-full power; Flyover-reduced power and Approach conditions were determined by entering the NPD regression line at the relevant reference corrected engine power setting: $N1\%/\sqrt{\Theta_{t2}}$; then the corrections for airspeed difference between NPD ground airspeed and the reference path ground speed, ΔS was applied. In particular Flyover level was finally calculated applying the correction for the minimum reference distance difference; this correction was got by recalculating the NPD regression line for the updated reference trajectory flight path minimum distance. In particular Lateral level was finally got applying the correction for the Reference overhead altitude H. Each certification condition: Flyover, Lateral and Approach noise level compliance was evaluated to assess the compliance to the regulation requirements, by comparing the corrected EPNLs, above calculated, to the applicable Regulation required limits, function of the a/c configuration and MTOW; the relevant 90% Confidence Interval was also calculated to demonstrate that each run's data not exceed the ±1.5 EPNdB.

[*ICAO Annex16, Chapter 3.3 and 4.4*]

5. COMPUTATION OF NOISE LEVELS

Noise certification data analysis results are presented in the following paragraphs. All present results for both “Simplified” and “Integrated” EPNL calculation methods given in accordance with ICAO Annex16, Volume I, Appendix II, Chapt. 9.1 for corrections to reference conditions, Noise-Power-Distance databases were developed as a function of normalized engine thrust/fan speed (N1%/$\sqrt{\Theta_{t2}}$) at the Lateral, Flyover and Approach conditions and minimum distance from the Reference flight path. The data reduction procedure was performed; in the following paragraphs the analysis and the calculated results for the three certification points are described:

- Lateral full power (Sideline),
- Flyover reduced power (Cutback),
- Approach

The parameter N1%/$\sqrt{\Theta_{t2}}$is calculated using the program DECA ref. [6].

5.1 Lateral (Sideline) NPD curve for RRJ-95B-100 model from certification flight test results.

Only the mean values analyzed data, being the set of data, referring to the same altitude (1042 ft), at the reference path speed of 167.3 KCAS, and different thrusts, have been analyzed as function of the normalized thrust/fan speed (N1%/$\sqrt{\Theta_{t2}}$) to derive the Lateral NPD curve. The EPNL values for the NPD database have been calculated for both Simplified and Integrated procedure.

The EPNL NPD values, calculated using the Simplified method, have been used to define the Lateral NPD curve, being verified that all the Rules constraints have been achieved to use them.

For reference Take-off condition: N1%cor.= N1%/√Θ = 93.5%; the value derived is **EPNL = 93.5 EPNdB** and the relative Interval of Confidence is: CI= ±0.268 EPNdB. The R^2 = 0988.

Figure 10 provides in graphic all valid mean test run’s EPNL, corrected for the reference trajectory as a function of normalized thrust/fan speed (N1%/$\sqrt{\Theta_{t2}}$); then the relevant 2nd order mean regression line calculated for these values. This regression line represents the Lateral NPD curve relevant for the reference test altitude (1042 ft) which equation is:

$$EPNL = 0.019642\ (N1\%\ /\ \sqrt{\Theta})^2 - 2.7406\ (N1\%\ /\ \sqrt{\Theta}) + 178.0341$$

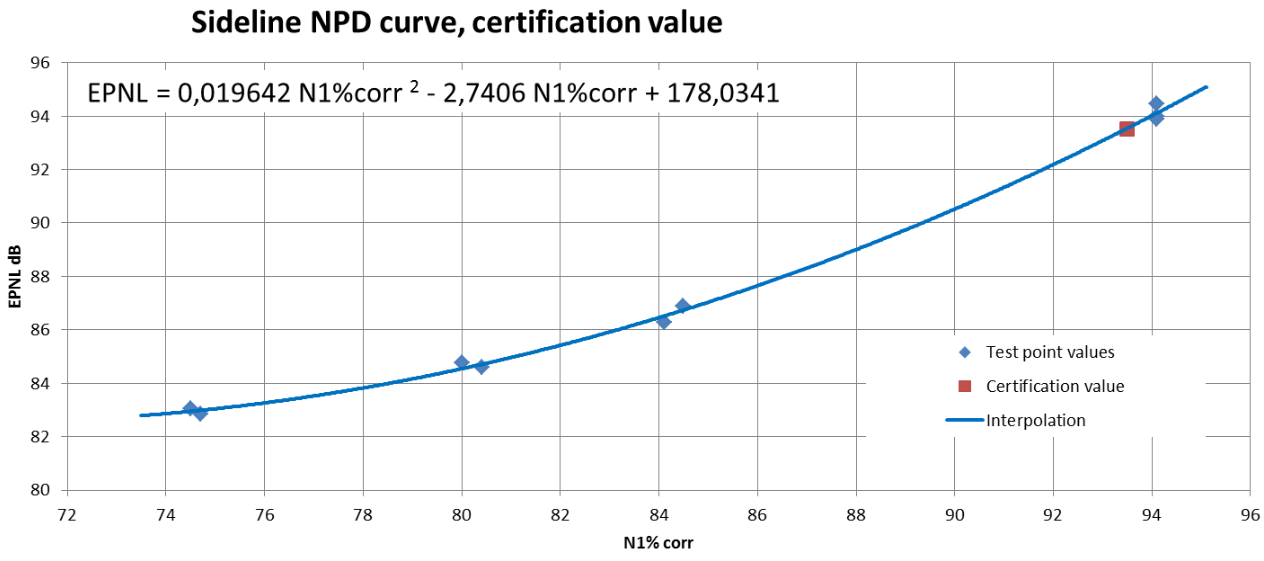


Figure 10 RRJ-95B-100 Lateral (Sideline) NPD curve: Mean Line, test points, certification value.

5.2 Lateral (Sideline) noise calculation for RRJ-95B-100 NMLGD model with reduced TOW=43.5 tons.

The Lateral (Sideline) Reference conditions for the RRJ-95B-100 NMLGD model are given by the following parameters:
• Aircraft configuration: MTOW=43500 Kg; Slat/Flap set for take-off; Bleed OFF, APU OFF,
landing gear up, CG middle.
• Trajectory parameters: flight path velocity =174.6 KTAS (169.0 KCAS); climb angle 10.95 dg; overhead altitude 1042 ft; $N1\% / \sqrt{\Theta_{t2}} = 93.5\%$
• Environmental conditions: ISA+10, Sea level, 70% Hr, no wind
The Lateral NPD curve, derived from the analysis is shown in figure 10 was also the equation of the regression curve of 2nd order is given. Since the Reference point to be entered in the curve to derive Noise Level remains unchanged for reduced TOW : $N1\%/\sqrt{\Theta_{t2}} = 93.5\%$; then Sideline noise level remains EPNL=93.5 EPNdB.
Effect of airspeed modification from 173.3 KTAS to 174.6 KTAS is calculated by the formula:
$\Delta EPNL = 10 * \lg (V_{was\ tas} / V_{is\ tas}) = 10 * \lg (174.6 / 173.3) = 0.03$ EPNdB
Sideline noise level with speed correction is **EPNL=93.47 EPNdB.**

5.3 Flyover (Cutback) NPD curve for RRJ-95B-100 model from certification flight test results.

The figure 11 provides the plot of all valid Flyover NPD curve test run's EPNL values, corrected for the reference trajectory as a function of normalized thrust/fan speed ($N1\%/\sqrt{\Theta_{t2}}$); and the relevant 2nd order mean regression lines, at the reference path speed of 175.4 KTAS. This regression line represents the Flyover NPD curve relevant for the reference minimum distance from the trajectory relative to the overhead altitude of 2263 ft which equation is:

$$EPNL = 0.01192\,(N1\%/\sqrt{\Theta_{t2}})^2 - 1.500553\,(N1\%/\sqrt{\Theta_{t2}}) + 126.4037$$

were $(N1\% / \sqrt{\Theta_{t2}})$ is the normalized thrust fan speed factor.

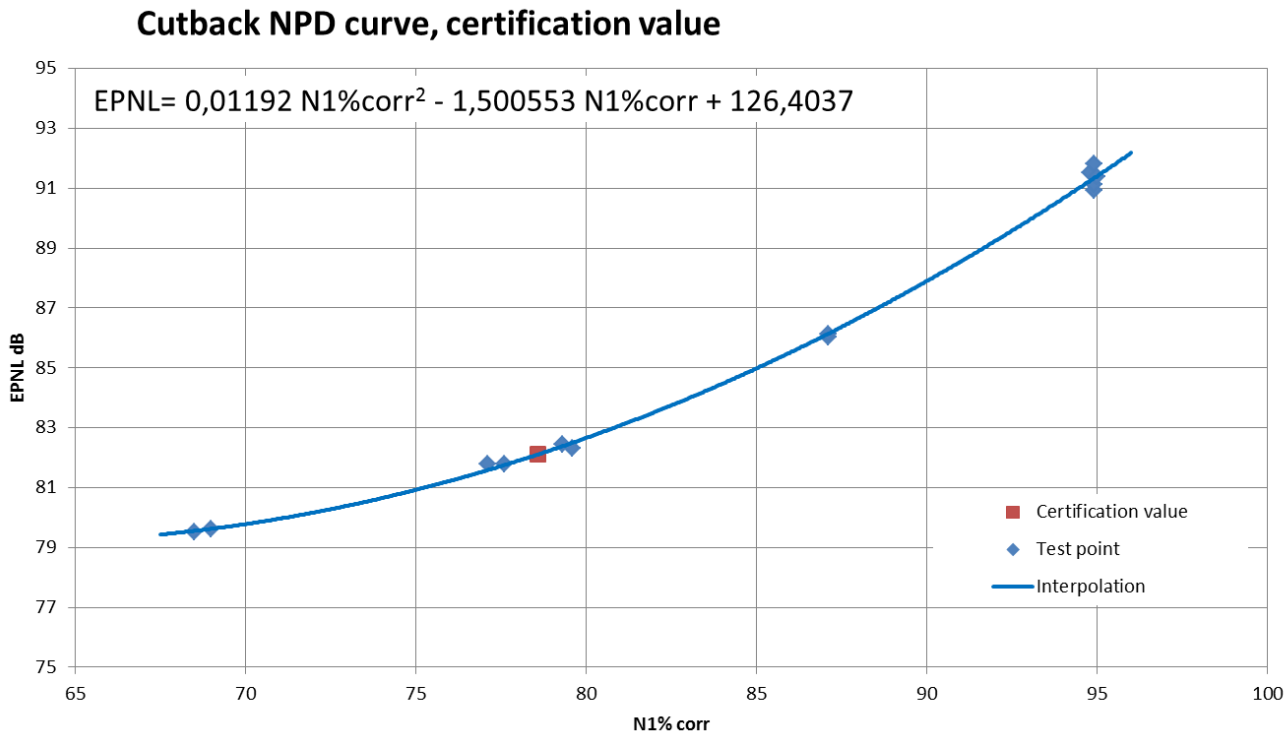


Figure 11 RRJ-95B-100 Flyover (Cutback) NPD curve: Mean Line, test points, certification value.

These EPNL for the NPD database derivation has been calculated for both Simplified and Integrated procedure.

The Flyover with reduced power (Cutback) Reference conditions for the RRJ-95B-100 model are given by the following parameters:

- Aircraft configuration: MTOW=45880 Kg; Bleed OFF, APU OFF, landing gear up, CG middle.
- Trajectory parameters: flight path velocity =175.4 KTAS (166.7 KCAS); climb angle 4.3 dg; overhead altitude 2263 ft; $N1\% / \sqrt{\Theta_{t2}} = 78.6\%$
- Environmental conditions: ISA+10, Sea level, 70% Hr, no wind

The Flyover NPD curve, derived from the analysis is shown in figure 11, where also the equation of the regression curve of 2nd order is given. The Reference point to be entered in the curve to derive the Certification Noise Level is: $N1\%/\sqrt{\Theta_{t2}} = 78.6\%$; **EPNL= 82.1 EPNdB**, and the relevant 90% Confidence Interval is ± 0.187 EPNdB.

5.4 Fly over (Cut back) noise calculation for RRJ-95B-100 NMLGD model with TOW limit of 43.5 tons.

To fulfill Bromma (ESSB) noise limit the new TOW limit of 43.5 tons is recommended. In that case three main parameter affecting noise should be taken into account:

- Increase of Fly-over altitude
- Decrease of required N1 after cut-back and
- Increase of TAS

Other parameters improve noise margin negligible and therefore have been not taken into account.

The Flyover with reduced power (Cutback) Reference conditions for the RRJ-95B NMLGD model are given by the following parameters:

• Aircraft configuration: MTOW=43500 Kg; Bleed OFF, APU OFF, landing gear up, CG middle.

• Trajectory parameters: flight path velocity =178.8 KTAS (169.0 KCAS); climb angle 3.66 dgr; overhead shifted altitude 2575 ft; $N1\% / \sqrt{\Theta_{t2}} = 76.4\%$

• Environmental conditions: ISA+10, Sea level, 70% Hr, no wind

The parameter $N1\%/\sqrt{\Theta_{t2}}$ is calculated using the program DECA ref. [6].

Effect of fly-over altitude increase from 689.7 m (2263 ft) for A/C with MTOW to 785m (2575ft) for A/C with TOW limited at 43.5 tons is calculated using the formula:

$\Delta EPNL_{ALT} = 20 * \lg (H_{was} / H_{is}) = 20 * \lg (689.7\ m / 785m) = -1.1$ EPNdB

Effect of decrease of required N1 after cut-back.

Certification $N1\%/\sqrt{\Theta_{t2}}$ reference point in the curve to derive the Certification Noise Level is: $N1\%/\sqrt{\Theta_{t2}} = 78.6\%$; EPNL= 82.1 EPNdB,

The Reference point RRJ-95B-100 NMLGD with TOW=43.5t to be entered in the curve to derive the Noise Level is: $N1\%/\sqrt{\Theta_{t2}} = 76.4\%$ instead of $N1\%/\sqrt{\Theta_{t2}} = 78.6\%$ EPNL=81.3 EPNdB;

$\Delta EPNL_{N1} = EPNL_{IS} - EPNL_{WAS} = 81.3 - 82.1 = -0.8$ EPNdB.

Effect of Increase of TAS should be taking into account as cumulative effect on duration due to airspeed change from 175.4 KTAS to 178.8KTAS and altitude increase from 689.7 m (2263 ft) for A/C with MTOW to 785m (2575 ft) for A/C with TOW limited at 43.5 tons. It is calculated by the formula:

$\Delta 2 = -7.5 * \lg(H_{was}/H_{is}) + 10 * \lg(V_{WAS}/V_{IS}) =$
$= -7,5 * \lg(689.7m/785m) + 10 * \lg(175.4/178.8) = 0.3$ EPNdB.

Taking into account the total value of corrections should consider reducing of noise level at Flyover point by:

$\Delta EPNL = \Delta EPNL_{ALT} + \Delta EPNL_{N1} + \Delta 2 = -1.1EPNdB + (-0.8EPNdB) + 0.3EPNdB = -1.6$ EPNdB.

Therefore for RRJ-95B-100 NMLGD with TOW limit=43.5 tons the calculated value of Flyover noise is **EPNL=80.5 EPNdB**

5.5 Approach NPD curve for RRJ-95B-100 model from certification flight test results.

Figures 12 provides the plot of all valid test run EPNL, used to define the Approach NPD curve for RRJ-95B-100, corrected for the reference trajectory as a function of normalized thrust/fan speed ($N1\%/\sqrt{\Theta_{t2}}$); then the relevant 2nd order mean regression lines. This regression line represents the Approach NPD curve and 90% CI, which equation is:

$$EPNL = 0.0077022\,(N1\%/\sqrt{\Theta_{t2}})^2 - 0.798045\,(N1\%/\sqrt{\Theta_{t2}}) + 113.647494$$

where ($N1\% / \sqrt{\Theta_{t2}}$) is the normalized fan speed.

The EPNL for the NPD database derivation has been calculated for both Simplified and Integrated procedure. The Reference point to be entered in the curve to derive the Certification Noise Level is: **EPNL= 93.05 EPNdB**.

Conditions: MLW=41000, Vref $_{APP}$=154.4 KCAS, Flap= FULL, APU: OFF, Bleed: ON, ISA+10°C, 70%Hr, SL, NO wind

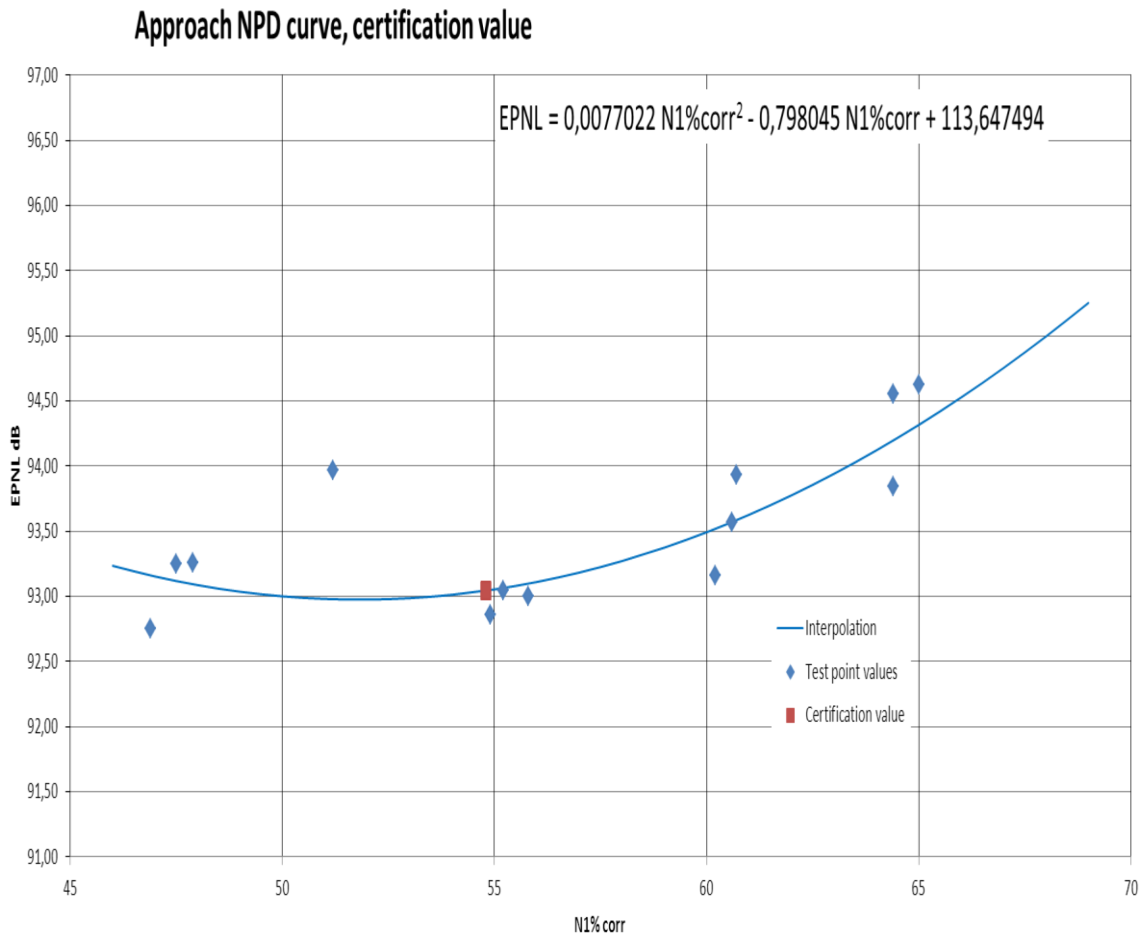


Figure 12 RRJ-95B-100 Approach NPD curve: Mean Line, test points, certification value.

5.6 Approach noise value for RRJ-95B-100 NMLGD model for Bromma (ESSB) limitations.

Since approach NPD curve shape at reference point is really flat and therefore no visible effect from landing weight reduction is expected. So for RRJ-95B-100NMLGD Approach Reference conditions for the ESSB operation remains the same as for certification check point:

- Aircraft configuration: MLW=41000 Kg; Slat/Flap Full; Bleed ON, APU OFF, landing gear down, CG foreword.
- Environmental conditions: ISA+10, Sea level, 70% Hr, no wind

- Trajectory parameters: flight path velocity =159.8 KTAS (154.4 KCAS); glide slope angle 3.0 deg; overhead altitude 394 ft; $N1\%/\sqrt{\Theta_{t2}}$ = 54.8%

Approach noise is **EPNL= 93.0 EPNdB**

6. CONCLUSIONS

New modification the Sukhoi RRJ-95B-100 NMLGD model powered by two turbofan SaM146-1S18 engines with the special operational limitation of takeoff gross weight (TOW limit) of 43500 kg and with structural maximum landing weight (MLW) of 41000 kg with noise average calculated values meets the requirements in Bromma airport.

Model TOW limit	Lateral Full power (Takeoff)	Flyover	Approach	Average value	Delta to Bromma limitation value 89 EPNdB
	SL EPNdB	FO EPNdB	AP EPNdB		
RRJ-95 B-100 NMLGD 43500 kg 41000 kg	**93.5**	**80.5**	**93.0**	**89.0**	**0.0**

7. Contact details

On behalf of SCAC

Kirill Alexandrovich Kuznetsov	K_Kuznetsov@scac.ru	Head of General Design NIO	General Design NIO
Alexandr Viktorovich Dolotovsky	A_Dolotovsky@scac.ru	Head of Aerodynamics NIO, Deputy Chief Designer for Aerodynamics	Aerodynamics NIO
Maria Sergeevna Voytishina	M_Voytishina@scac.ru	Head of Flight Mechanics Department	Flight Mechanics Department
Polina Alexandrovna Khizhnyak	P_Khizhnyak@scac.ru	Head of Type Certification Department	Type Certification Department
Dmitry Igorevich Nikolaev	D_Nikolaev@scac.ru	1st Category Design Engineer	Power Plant Department

SUKHOI
CIVIL AIRCRAFT

8. Registration and approval record sheet

Description	
Identifier	RRJ0000-RP-009-4241/B
Replaces	-
Developer	Power plant department (009)
Authors:	Deputy Head of NIO Head of Power Plant Department ______ M. M. Polovin 1st Category Design Engineer ______ D. I. Nikolaev

AGREED:

Head of General Design NIO ______ K.A. Kuznetsov

Head of Aerodynamics NIO, Deputy Chief Designer for Aerodynamics ______ A.V. Dolotovsky

Head of Flight Mechanics Department ______ M.S. Voytishina

Head of Type Certification Department ______ P. A. Khizhnyak