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Determination of Base Pressure for the Agard-B Calibration Model and Comparision with an Experiment in the T-38 Wind Tunnel

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The results of the base pressure measurements of the AGARD-B calibration model in the T-38 blowdown wind tunnel of the Military Technical Institute Serbia are given in this article. There is very good agreement between the measured base pressures in the MTI T-38 blowdown wind tunnel and the appropriate measured values in the IAR (NAE) 5ft trisonic wind tunnel (Canada). Also Computational Fluid Dynamics (CFD) calculations have been performed to predict base pressure values and the results are compared against both wind tunnel test results. The influence of the sting on the calculated values of the base pressures is established. The measured base pressures are between the calculated values for the CFD model alone and the CFD model with sting. The base pressures are also calculated by the semi-empirical method, MTI-DMAC at zero angle of attack and the USAF Missile DATCOM as a function of the angles of attack. The differences between the calculated and the measured base pressure can be related to the influence of the sting.

Key words: **experimental aerodynamics, fluid dynamics, numerical simulation, base pressure, pressure coefficient.**

Introduction

THE AGARD-B calibration model is an ogive-cylinder with a delta wing, originally designed for the supersonic wind tunnels calibration. This calibration model is usually used for transonic wind tunnels calibration.

A series of wind tunnel tests of the AGARD-B calibration model is performed in the T-38 trisonic blowdown wind tunnel of the Military Technical Institute of Serbia. A part of these tests is base pressure measurements.

The first purpose of this paper is to compare the measured base pressure with the base pressure measurements of the same model performed in the IAR (NAE) 5ft trisonic wind tunnel (Canada).

The second purpose of this paper is to compare the calculated with the measured base pressure of the AGRAD-B calibration model. Steady state calculations are used to compute the base pressures values using the commercial CFD code FLUENT. Solutions are also obtained with the semi-empirical, engineering level design codes, the Missile DATCOM and the DMAC.

Model

The AGARD-B calibration model (Fig.1) is a missile configuration with a cylindrical body and planform delta wings, [1].

The model body is a cylindrical body with an ogive nose. The span of the delta wings with the body is equal to four diameters. The pertinent dimensions of the model are given as a function of the body diameter *D* (Fig.2).

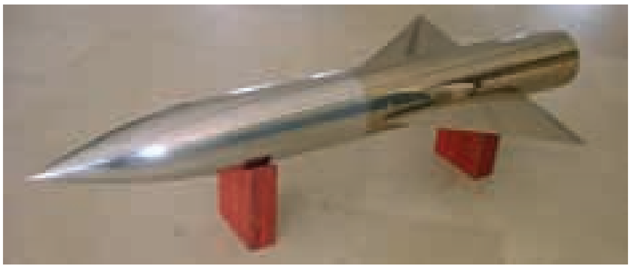

Figure 1. AGARD-B model

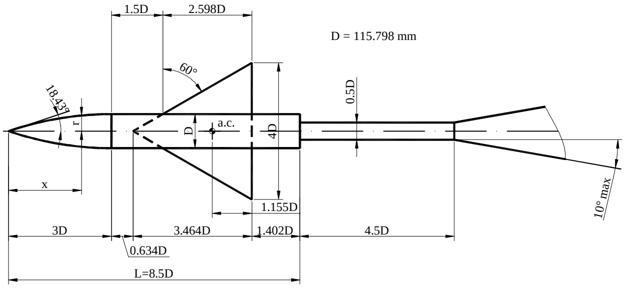

Figure 2. Basic dimensions of the AGARD-B model

The AGARD-B wind tunnel calibration model used in the T-38 wind tunnel is supplied by BOEING, USA. A model size is chosen with respect to the tunnel test section size.

There is an extensive database of the base pressure measurements which can be used for a comparison with the

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measurements of the current test in the VTI T-38 wind tunnel. This database of the base pressure measurements is a result of the previous wind tunnel calibrations of the VTI T-38 wind tunnel and the results of the NAE measurements [2].

The tail sting is used to support the model. The male end of the sting is inserted into the model support boss, which is attached to the strut.

The sting diameter is 57.9 mm, the length of the straight part of the sting being 702.3 mm. The angle of a conical transition of the sting into support is 7.9°. The length of the straight part of the sting behind the model base is 603 mm. The sting diameter vs. the model base diameter ratio is 0.5 and the sting length vs. the model base diameter ratio is 5.2, which is a little above the recommended values for the minimum sting interference (Fig.2).

The VTI six-component balance is used for forces and moments measurements. The "live" side of the balance is fitted into a cylindrical adaptor rigidly attached to the model (Fig.3). The pressure in the cavity surrounding the sting at the model base (i.e. the base pressure) is sensed by a single orifice at the end of a tube, which is routed through the balance adaptor to the sensor located below the strut of the model support.

The picture of the AGARD-B calibration model mounted in the T-38 test section is given in Fig.4.

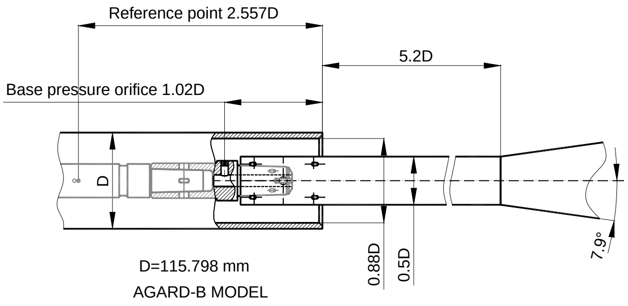

Figure 3. Relationship of sting to the AGARD-B model

Figure 4. AGARD-B model mounted in the T-38 test section

Test facility

The T-38 test facility at the Military Technical Institute is a blow-down pressurized wind tunnel with a 1.5m x 1.5m square test section, [3]. For subsonic and supersonic tests, the test section is with solid walls, while for transonic tests, a section with porous walls is inserted in the tunnel configuration. The porosity of walls can be varied between 1.5% and 8% in order to obtain the best flow quality.

Mach number in the range 0.2 to 4.0 can be achieved in the test section, with Reynolds numbers up to 110 million per meter. In the subsonic configuration, Mach number is set by sidewall flaps in the tunnel diffuser. In the supersonic configuration, Mach number is set by the flexible nozzle contour, while in the transonic configuration, Mach number is both set by sidewall flaps and the flexible nozzle, and actively regulated by the blow-off system. Mach number can be set and regulated to within 0.5% of the nominal value.

Stagnation pressure in the test section can be maintained between 1.1 bars and 15 bars, depending on Mach number, and regulated to 0.3% of the nominal value. Run times are in the range 6s to 60s, depending on Mach number and stagnation pressure.

The model is supported in the test section by a tail sting mounted on a pitch-and-roll mechanism by which desired aerodynamic angles can be achieved. The facility supports both step-by-step model movement and continuous movement of model ("sweep") during measurements.

The positioning accuracy is 0.05° in pitch and 0.25° in roll.

Instrumentation, data recording and reduction

The stagnation pressure P_0 in the test section is measured by a Mensor quartz bourdon tube absolute pressure transducer pneumatically connected to a pitot probe in the settling chamber of the wind tunnel. The range of the transducer used is 7 bars. The nonlinearity and hysteresis of this transducer is typically 0.02% F.S. An end-to-end calibration of the transducer and the data acquisition channel is performed using a Mensor quartz secondary pressure standard.

The difference P_{st}-P_0 between the stagnation and static pressure in the test section is measured in the subsonic speed range by a Mensor quartz bourdon tube differential pressure transducer pneumatically connected to the P_0 pitot probe and to an orifice on the test section sidewall. In the transonic and supersonic speed range an absolute pressure transducer of same type and range is used. The range of these transducers is 1.75 bar; the nonlinearity and hysteresis is about 0.02% F.S. The transducers are calibrated in the same manner as the P_0 transducer.

The stagnation temperature T_0 is measured by a RTD probe in the settling chamber. The accuracy of this transducer is approximately ±0.5K.

The pitching angle of the model support is measured by a resolver mounted in the mechanism. The accuracy of the pitching angle reading is 0.05°.

The base pressure P_b is measured by a Druck PDCR42 piezoresistive differential pressure transducer (actually, P_b-P_{st} is measured). The range of this transducer is 0.35 bars, with 0.05% F.S. nonlinearity and hysteresis.

The aerodynamic forces and moments acting on the model are measured by the VTI40A internal six-component strain gauge balance. The range of the balance is 1130 N for axial force, 5000 N for side force, 10150 N for normal force, 184 Nm for a rolling moment, 530 Nm for a pitching moment and 256 for a yawing moment and the accuracy is approximately 0.20% F.S.

A checkout of the balance is performed by applying dead weights at known locations immediately prior to testing, and it is confirmed that the accuracy is within the nominal limits.

The output of a precision digital clock is sampled synchronously with other channels, in order to serve as a time base for the segmentation of data.

The data acquisition system consisted of a Teledyne 64 channel “front end” controlled by a PC computer. The front-end channels for flow parameters transducers (i.e. P_0, P_{st}-P_0 and T_0) are set with 10 Hz fourth-order low pass Butterworth filters and appropriate amplification.

In order to minimize the differences in time lags on various channels during the model sweep, the channels for six balance components and the base pressure are set with 30 Hz low pass filters. In order to compensate for the poorer filtering on these channels, these signals are additionally filtered during the data reduction by a 3 Hz non-casual low pass digital filter.

The data from all analog channels are digitized by a 16-bit resolution A/D converter with the overall accuracy of the acquisition system about 0.05% F.S. of the channel signal range. All channels are sampled with the same 200 samples/s rate.

The digitized data are sent through the network to a COMPAQ Alphaserver DS20E computer and stored on disk for later reduction.

The data reduction is performed after each run, using the standard T38-APS software package. It is done in several stages, i.e.:

- Data acquisition system interfacing and signals normalization;
- Determination of flow parameters;
- Determination of model position (orientation);
- Determination of aerodynamic coefficients.

Each stage is performed by a different software module.

Wind tunnel test results

The base pressure measurements are done with a stagnation pressure of 2.3 bar and zero roll angle of the model.

The base pressure test results of the AGARD-B calibration model are compared with the results of the tests of the same model performed in 1981 in the IAR (NAE) 5ft trisonic wind tunnel (Canada), [4]. The comparisons of the measured base pressures are given in a form of graphs (Figures 5-12).

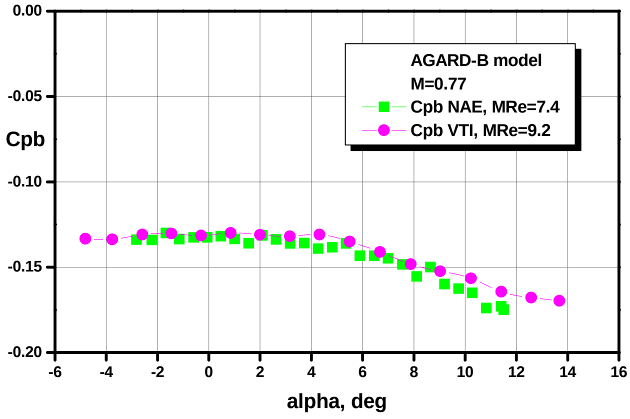

Figure 5. Comparisons of the base pressure coefficient at M=0.77

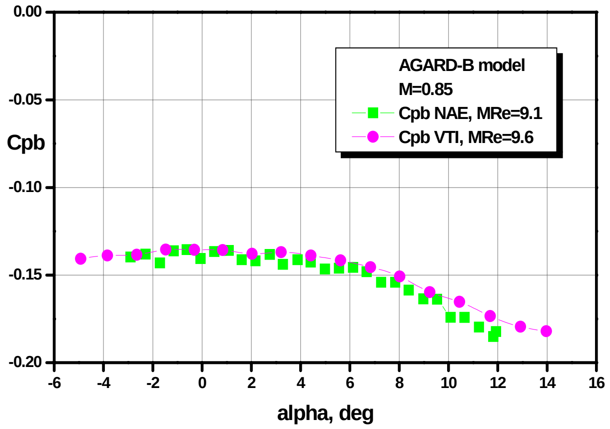

Figure 6. Comparisons of the base pressure coefficient at M=0.85

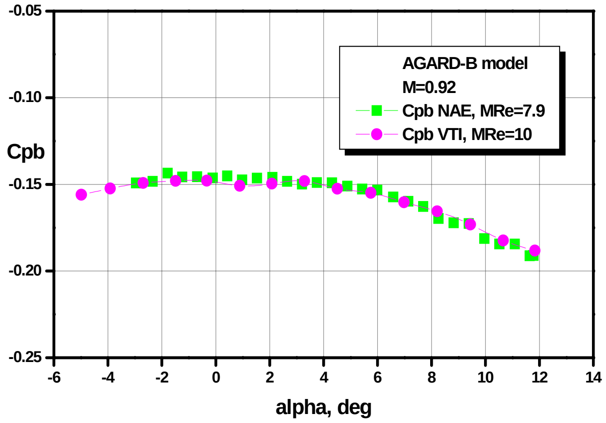

Figure 7. Comparisons of the base pressure coefficient at M=0.92

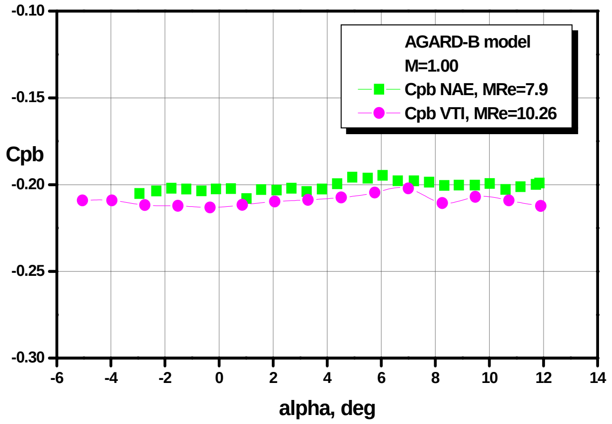

Figure 8. Comparisons of the base pressure coefficient at M=1.0

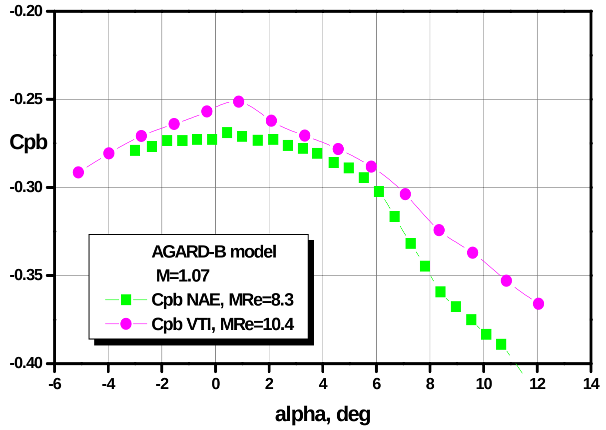

Figure 9. Comparisons of the base pressure coefficient at M=1.07

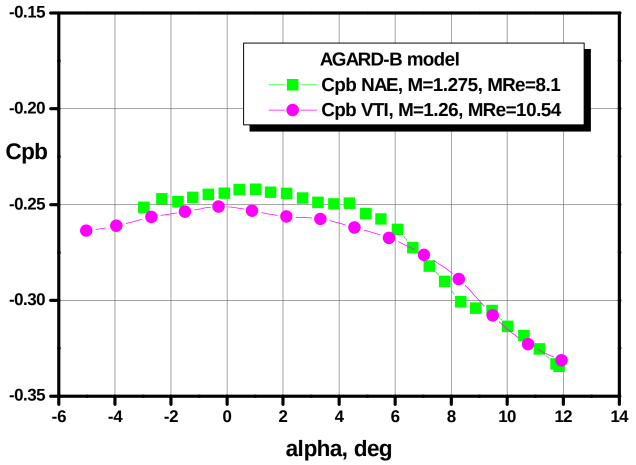

Figure 10. Comparisons of the base pressure coefficient at M=1.27

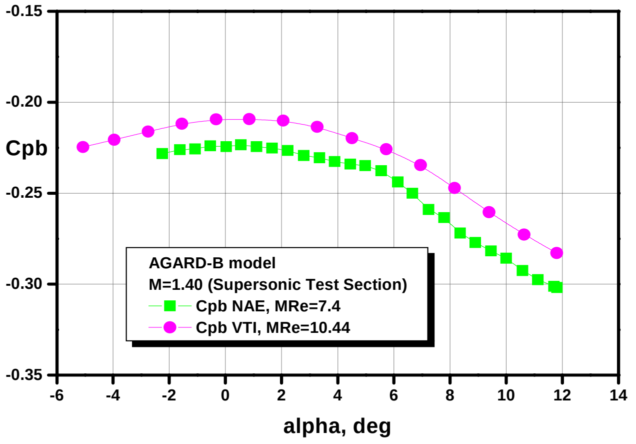

Figure 11. Comparisons of the base pressure coefficient at M=1.4

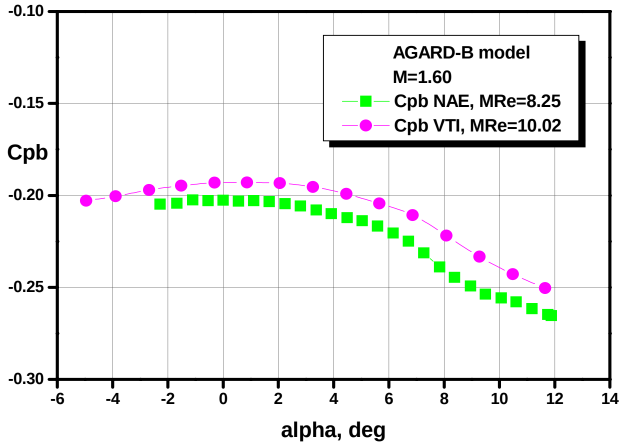

Figure 12. Comparisons of the base pressure coefficient at M=1.6

There is some disagreement between these two measurements. It can be explained by the fact that the range of measurements and accuracy of measurements are not the same for IAR (NAE) and VTI pressure transducers.

Base pressure calculation by a semiempirical method

A physical model and the correlation between the base pressure and Mach numbers, the base configuration of the body shape, Reynolds numbers, the angles of attack and body heating are treated in detail in [5],[6].[10].

The influence of the Reynolds numbers on the base pressure is significant in the pure laminar flow which can be realized at low Mach numbers. In real conditions, the boundary layer of the missile is turbulent. It is shown by the experiments that the influence of the Reynolds numbers on the base pressure is small in the case of the turbulent flow and that it can be neglected from the practical point of view [5], [6], [7], [8], [9], [10], [11].

In the case of the turbulent flow, the base pressure is strongly dependent on Mach numbers, the missile base shape, the thickness of the tail airfoils and the tail position relative to the missile base. It is noticed that moving the tail fins forward from the missile base decreases the base pressure. When the tail fins are moved 1 chord length forward, the increase of the base drag due to tail fins is eliminated [5],[10],[11].

The base pressure components of the body alone and the wings alone of the AGARD-B calibration model are given in Fig.11 [6].

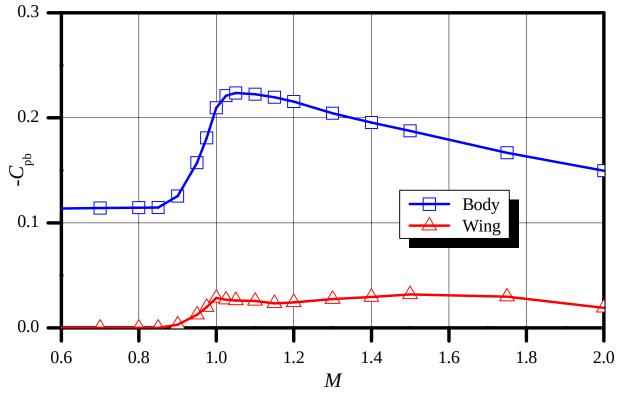

Figure 11. Body and wing base pressure components of the AGARD-B calibration model

Since the wing trailing edge of the AGARD-B calibration model is located 0.538 chord length forward from the base of the model, there is almost no influence of the wing base pressure to the base pressure of the whole model. The calculated and measured values of the base pressure of the AGARD-B calibration model at zero angle of attack are given in Fig.12. The difference between the calculated and the experimental data can be related to the inaccurate consideration of the sting contribution to the base pressure measurements.

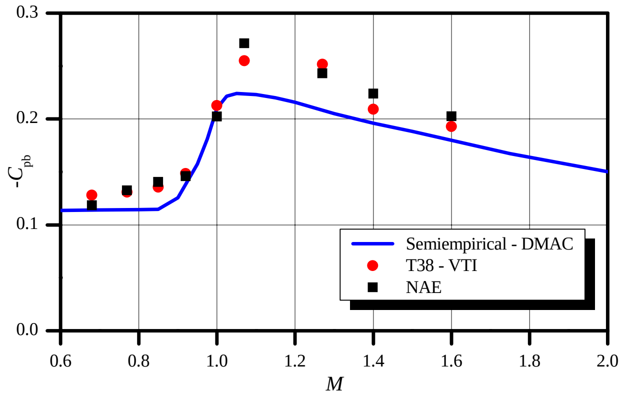

Figure 12. Base pressure of the AGARD-B calibration model

CFD simulation

Viscous computational fluid dynamic simulations are used to calculate the flowfield and base pressure coefficients for the AGARD-B test model in subsonic, transonic and supersonic flows. Computations are performed at Mach numbers ranging from 0.6 to 1.8 at four angles of attack between 0 and 12 deg. AGARD-B calibration models with and without a sting are modeled to detect a sting effect.

Solid Model and Computational Mesh

Two geometries are generated for the CFD studies. One of them includes both the AGARD-B calibration model and the sting which is used in the T-38 trisonic blowdown wind tunnel test, the other geometry consists of only the AGARD-B calibration model. The generated solid models are shown in Fig.13 and Fig.14.

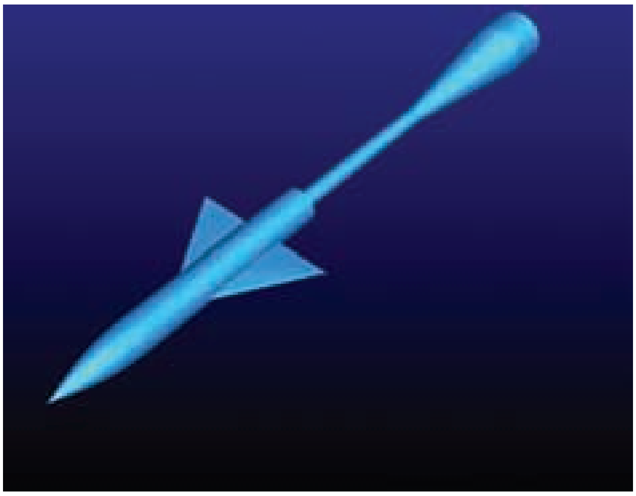

Figure 13. AGARD-B calibration model with a sting

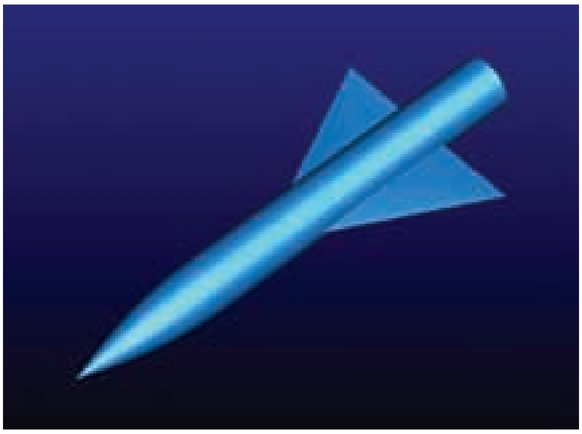

Figure. 14. AGARD-B calibration model

Both the solid model and the unstructured hybrid meshes are generated using the GAMBIT of FLUENT software package. The computational domain inlet is located 10 model body length upstream from the tip of the model nose and the computational domain outlet is located 18 model body length downstream from the model base.

A grid resolution study is conducted. For this study, the mesh adaptation tool in the FLUENT software is used to determine mesh independence. The mesh for the AGARD-B model without a sting is adapted w.r.t. the static pressure gradient using this adaptation tool. After the grid adaptation, solutions are repeated until convergence is achieved. The maximum change in the aerodynamic coefficients is about 0.5 %. These results show that the original mesh used for all cases had a high enough resolution for a mesh independent solution. Figures 15 and 16 show the surface meshes of the original grid with and without a sting, respectively.

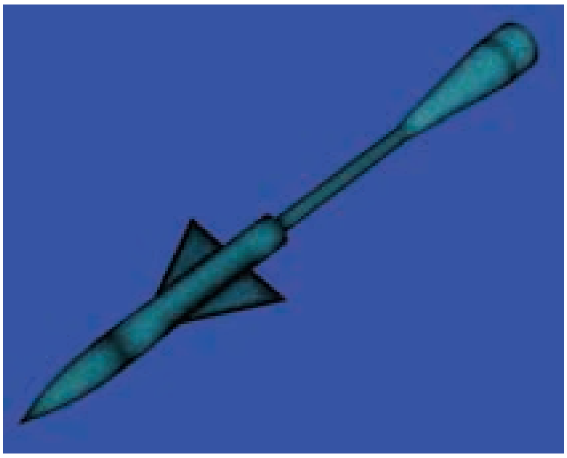

Figure 15. Surface Grid for the AGARD-B model with a sting

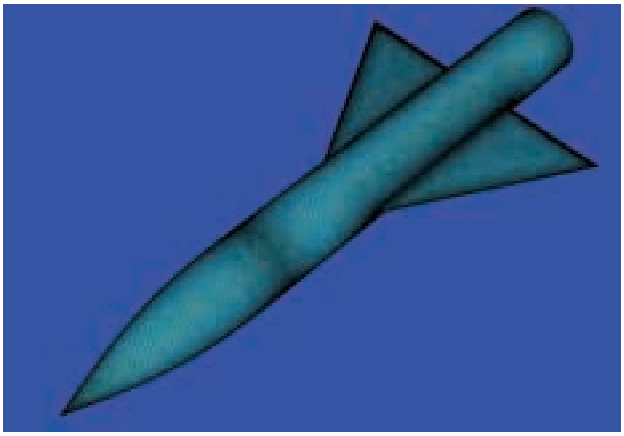

Figure 16. Surface Grid for the AGARD-B model

In generating the meshes, boundary layer mesh spacing is used near the AGARD-B model. The two-layer zonal model is used for the near-wall equations and the first point off the surface is chosen to give y+ value of about 1.0. 20 layers of prismatic cells are generated to adequately resolve the boundary layer. The remaining part of the solution domain is completely composed of tetrahedral elements. The mesh growth rate is kept below 1.15. The cross-sectional views from the volume mesh are shown in Figures 17 and18.

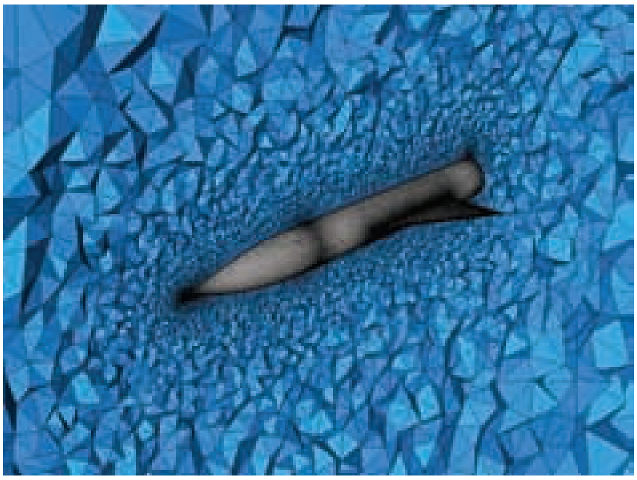

Figure 17. Computational Grid for the AGARD-B model

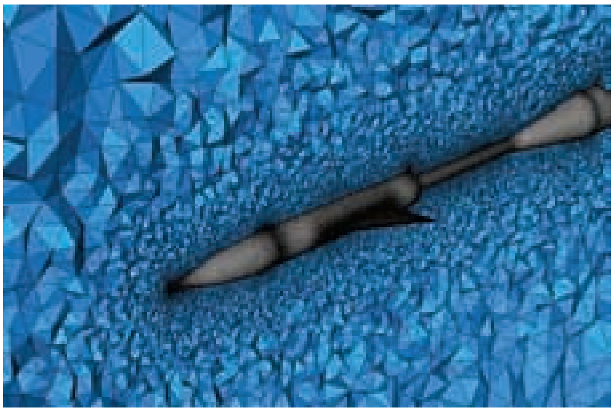

Figure 18. Computational Grid for the AGARD-B model with a sting

Post-processing of the runs shows that the y+ value is in the range of 0.6-1.5 on the model nose, less than 1.0 on the model wing, the body and the base region. Fig. 19 shows the y+ values for the AGARD-B model without a sting at Mach number 1.8.

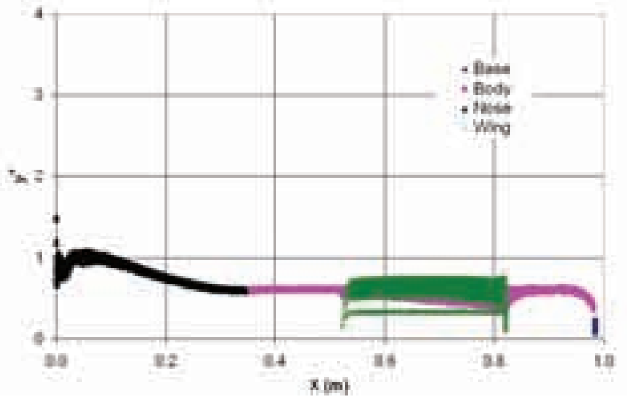

Figure19. y+ values at Mach 1.8 for the AGARD-B model without a sting

Flow solver and boundary conditions

The FLUENT (v6.2.16) commercial flow solver is used to compute the base pressure values and the flow field around the AGARD-B test model. The implicit, compressible, unstructured-mesh solver is used. The three-dimensional, time-dependent, Reynolds-Average Navier-Stokes (RANS) equations are solved using the finite volume method:

$$\frac{\partial}{\partial t}\int_V W dV + \oint [F - G] \cdot dA = \int_V H dV$$

where

$$W = \begin{Bmatrix} \rho \\ \rho u \\ \rho v \\ \rho w \\ \rho E \end{Bmatrix}, F = \begin{Bmatrix} \rho v \\ \rho v u + p i \\ \rho v v + p j \\ \rho v w + p k \\ \rho v E + p v \end{Bmatrix}, G = \begin{Bmatrix} 0 \\ \tau_{xi} \\ \tau_{yi} \\ \tau_{zi} \\ \tau_{ij} v_j + q \end{Bmatrix}$$

The inviscid flux vector F is evaluated by a standard upwind flux-difference splitting. In the implicit solver, each equation in the coupled set of governing equations is linearized implicitly with respect to all dependent variables in the set, resulting in a block system of equations. A block Gauss-Seidel point implicit linear equation solver is used with an algebraic multigrid method to solve the resultant block system of equations.

The coupled set of governing equations is discretized in time and time marching proceeds until a steady state solution is reached. In the implicit scheme, which is used in this study, an Euler implicit discretization in time is combined with a Newton-type linearization of the fluxes. Second-order discretization is used for all flow variables.

A modified form of the k- ε two-equation turbulence model (realizable k- ε) is used in this study. This turbulence model solves transport equations for the turbulence kinetic energy, k, and its dissipation rate, ε. The term “realizable” means that the model satisfies certain mathematical constraints on the Reynolds stresses consistent with turbulent flow physics. The realizable k-ε model has shown substantial improvements over the standard k-ε model where flow features include strong streamline curvature, vortices, and rotation.

The boundary conditions are as follows. Downstream, upstream, and outer radial boundaries are set as far-field (characteristics-based inflow/outflow), with sea-level temperature and pressure free stream conditions (300 K, 101325 Pa). The symmetry boundary condition is used for the symmetry plane. All the solid surfaces are modeled as a no-slip, adiabatic wall boundary conditions.

The model reference length is 267.4 mm which is a wing mean aerodynamic chord length, and the moment reference point (MRP) is 688.18 mm aft of the missile nose. The reference area is 0.0929 m^2.

Solution Strategy

The viscous computational fluid dynamics simulations are performed in the ROKETSAN’s High Performance Computing (HPC) system. The 52 CPUs parallel supercomputer *ANITTA* is used for this study. The simulations are done with a maximum Courant-Friedrich-Lewy (CFL) number of 8 for all Mach numbers. Each case is started with a lower CFL value of 1.0 and ramped up to the maximum during the simulation iterations. The calculations took about 16 – 40 s of the CPU time per iteration and convergence is achieved in about 2500–3000 iterations, depending on the Mach number and the angle of attack. The convergence is determined by tracking the change in the flow residuals and the aerodynamic coefficients during the solution. The solution is converged when the flow residuals are at least three orders of magnitude and the aerodynamic coefficients are changed less than about 1% over the last 100 iterations. The aerodynamic coefficients are the determining factor in convergence. Fig.20 gives the residuals graph for M = 1.8 and α = 12 degree.

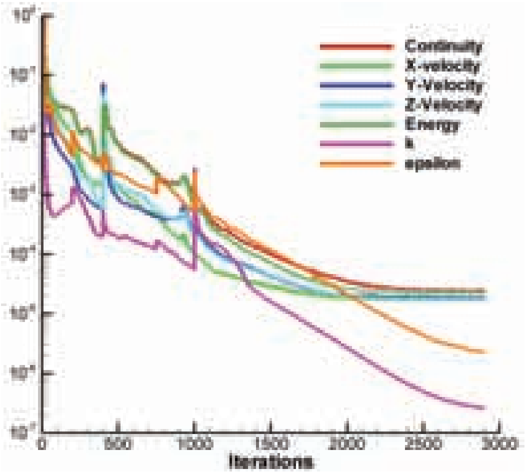

Figure 20. Pressure contours and streamlines for the model without a sting at M=0.6 and at α= 12 deg

Flow-Field visualizations

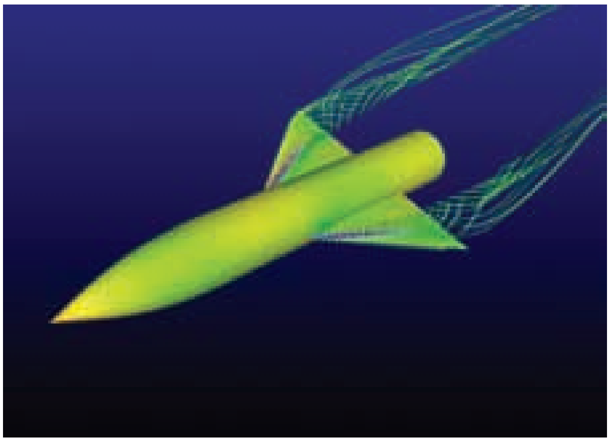

Figure 21. Pressure contours and streamlines for the model without a sting at *M*=0.6 and at *α*= 12 deg

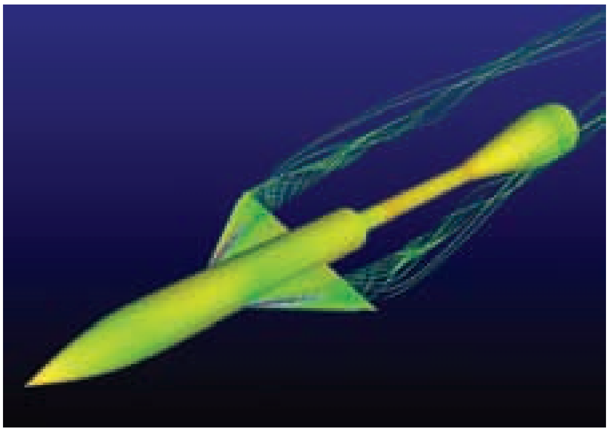

Figure 22. Pressure contours and streamlines for the model with a sting at *M*=0.6 and at *α*= 12 deg

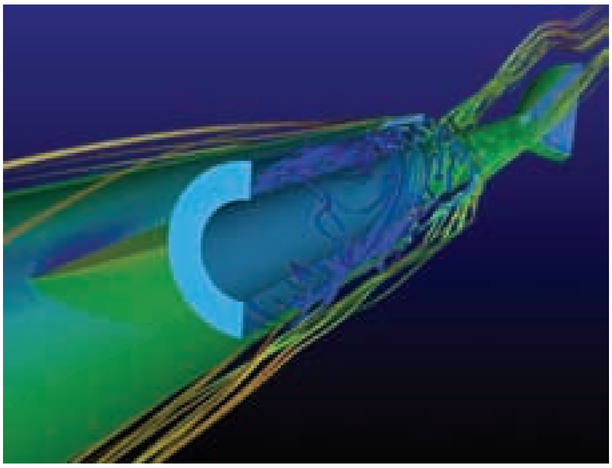

Figure 23. Pressure contours and streamlines around the sting region at *M*=0.6 and at *α*= 12 deg

Missile DATCOM (ver 97) Prediction

The Missile DATCOM is a semi-empirical code which is developed by U.S. Air Force Flight Dynamics Laboratory for missile and rocket aerodynamic parameter estimation in conceptual and preliminary design phases.

Configuration modeling options include axi-symmetric or elliptically shaped bodies that are defined by a geometry type or surface coordinates. Up to four non-overlapping fin sets can be specified. Eight panels can be modeled for each fin set. This code predicts all longitudinal and lateral static and dynamic derivatives.

The Missile DATCOM predicts 6-DOF aerodynamic coefficients under the following conditions: Mach numbers between 0 and 10, angles of attack from –180º to +180º, roll angles from 0º to 360º, and combined angle of attack plus fin deflection angles up to 60º. Flight conditions can be user-defined, or set using a Standard Atmosphere model. Component buildup results for isolated components and partial configurations are provided.

The Missile DATCOM has the capability to perform a static trim of a configuration, using any fin set for control with fixed incidence on the other sets. With this option, the trimmed aerodynamic coefficients and the trim deflection angle are provided as a function of the angle of attack. Another particularly useful option is the capability to substitute experimental data in place of an airframe component or a partial configuration at a specific Mach number.

Results and Discussion

In this section, the results of the computed and measured base pressure coefficient comparisons are presented. There are very good agreements between all CFD results and the experimental data from the VTI and NAE wind tunnels. These agreements between computed and measured results reveal that the CFD accurately captured a base flow phenomenon.

The comparisons of the predicted and measured base pressure coefficients at M = 1.8 are shown in Fig.24. The CFD predictions compare very well to the measured C_{Pb}. The sting-included case CFD results predict the base pressure coefficients accurately over the entire angle of attack range. The sting-excluded CFD results are slightly higher than the experimental results, but the trend of the base pressure decrease with α is predicted well. The base pressures are not calculated accurately by the Missile Datcom programme in the entire range of the angles of attack. The difference between the Missile Datcom predictions and the measured values increases with the increasing of the angle of attack.

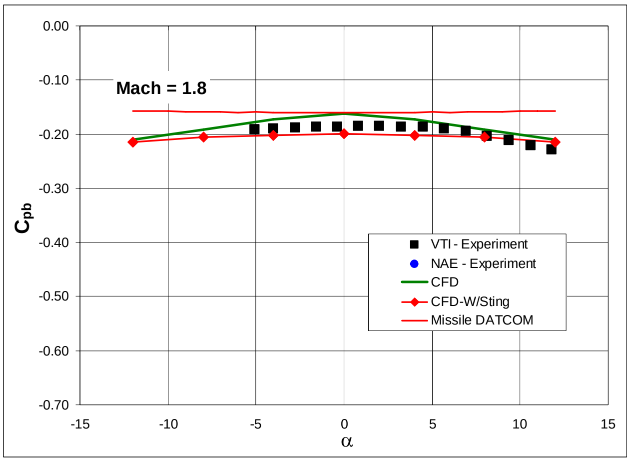

Figure 24. Comparisons of the experimental base pressure coefficient with the CFD and the empirical results at *M*=1.8

The computed and measured base pressure coefficients for M = 1.6 are compared in Fig.25. The general trends are similar to those observed at M = 1.8. Again the CFD computations give accurate results, but the Missile Datcom predictions are poor, especially at high angle of attacks.

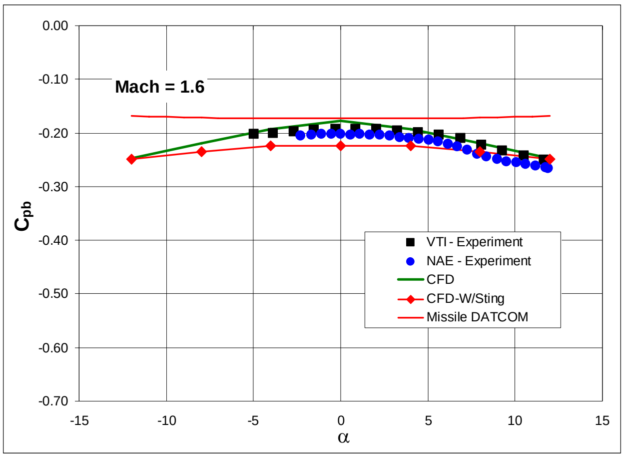

Figure 25. Comparisons of the experimental base pressure coefficient with the CFD and the empirical results at *M*=1.6

The results of the predicted and measured base pressures coefficients at *M* = 1.4 are given in Fig.26. The sting-included CFD computations predict the measured base pressure values well for angle of attacks higher than 5 degrees. The base pressures of the model alone calculated by the CFD are almost equal to the VTI measurements.

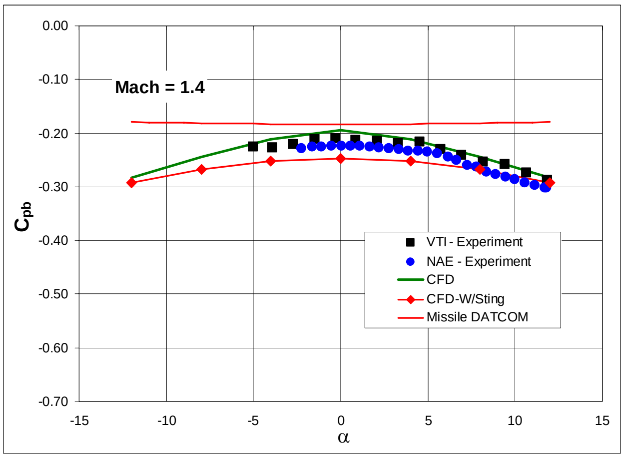

Figure 26. Comparisons of the experimental base pressure coefficient with the CFD and the empirical results at *M*=1.4

The comparisons of the calculated and measured base pressure for *M* = 0.85 and *M* = 0.6 are shown in Figures 27 and 28, respectively. At subsonic speeds, the Missile Datcom gives better results than the CFD results, which is puzzling. This may result from an inappropriate turbulence model selection.

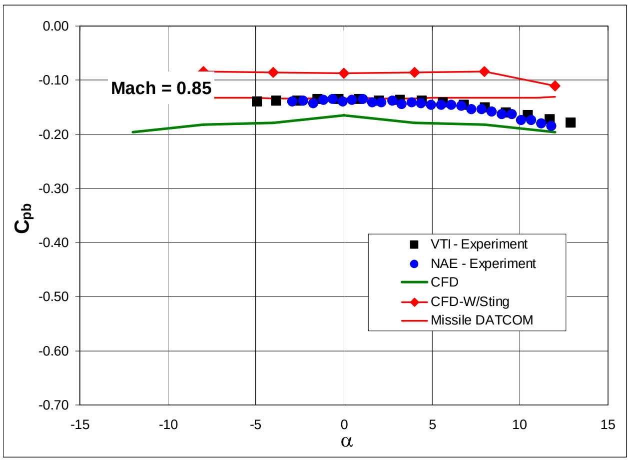

Figure 27. Comparisons of the experimental base pressure coefficient with the CFD and the empirical results at *M*=0.85

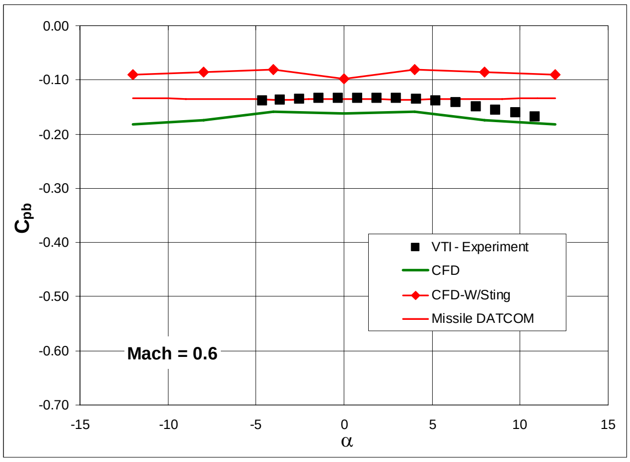

Figure 28. Comparisons of the experimental base pressure coefficient with the CFD and the empirical results at *M*=0.6

Conclusion

An accurate estimation of the base pressure requires calculations and measurements in a wind tunnel. There are two methods of the base pressure calculations: semi-empirical and CFD methods. The CFD calculations of the base pressure are done by the FLUENT.

As a part of the MTI (Military Technical Institute) T-38 wind tunnel calibration, the series of the base pressures measurements are performed for the AGARD-B calibration model. There are good agreements between the base pressures measurements in the MTI T-38 wind tunnel and the IAR (NAE) 5ft trisonic wind tunnel in Canada.

The base pressure calculated by the semi-empirical method can be compared with the measurements only for the zero angle of attack. The base pressures calculated by the DMAC program are lower than the values measured in the wind tunnel. The values of the base pressures calculated by the Missile DATCOM program are also lower than those measured in the supersonic region of the Mach numbers and they are equal to the measured values in the subsonic and transonic region of the Mach numbers.

The CFD calculations of the base pressures by the FLUENT software package are done for both the AGARD-B model alone and the AGARD-B model with a sting. In the supersonic region of the Mach numbers the base pressures of the model alone, calculated by the CFD, are lower than the measured values. For the same Mach numbers, the calculated values of the base pressure of the model with a sting are higher than the measured values. In the subsonic and transonic region (*M*=0.6 and *M*=0.85) the influence of the sting is opposite regarding the supersonic region. This should be investigated by the different turbulence models. The increase of the base pressure with the increase of the angle of attack is very well predicted by the CFD software FLUENT.

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Određivanje baznog pritiska za kalibracioni model AGARD-B i poređenje sa eksperimentima u aerotunelu T-38 VTI

U radu su dali rezultati merenja baznog pritiska za kalibracioni model AGARD-B u aerodinamičkom tunelu T-38 Vojnotehničkog instituta, Srbija. Na osnovu uporednih dijagrama pokazano je dobro poklapanje između baznog pritiska izmerenog u aerotunelu T-38 i baznog pritiska izmerenog u aerotunelu IAR (NAE), Kanada. Program FLUENT, numerička aerodinamika, korišćen je za izračunavanje baznog pritiska za kalibracioni model AGARD-B sa i bez stinga. Rezultati proračuna pokazali su da je evidentan uticaj stinga i da se izmerene vrednosti baznog pritiska nalaze između izračunatih baznih pritisaka za model sa i bez stinga. Bazni pritisak za isti model izračunat je pomoću programa semiemirijske aerodinamike (DMAC i Missile DATCOM) za nulti napadni ugao. Razlika između izračunatog i izmerenog baznog pritiska povezana je sa uticajem stinga.

Ključne reči: **eksperimentalna aerodinamika, dinamika fluida, numerička simulacija, bazni pritisak, koeficijent pritiska.**

Цифровое и экспериментальное определение базового давления на тарированной модели АГАРД-Б

В настоящей работе показаны результаты измерения базового давления для калиберной модели АГАРД-Б в аэродинамической трубе Т-38 Военно-технического института Сербии. На основании сравнительных диаграмм показано хорошее совпадение между базовым давлением измереным в аэродинамической трубе Т-38 и базовым давлением в аэродинамической трубе ИАР (НАЕ) в Канаде. Програма ФЛУЕТ, цифровая аэродинамика, использована для высчитывания базового давления для калиберной модели АГАРД-Б со жалом и без него. Результаты высчитывания показали, что учётным является влияние жала и что измерение значения базового давления находятся между высчитанными базовыми давлениями для модели со жалом и без него. Базовое давление для такой же модели высчитано при помощи програмы семи-эмпарической аэродинамики (ДМАЦ и Миссиле ДАТЦОМ) для нулевого угла атаки. Разница между высчитанным и измереным базовыми давлениями связана со влиянием жала.

Ключевые слова: **экспериментальная аэродинамика, динамика жидких тел (флуидов), цифровое моделирование, базовое давление, коэффициент давления.**

Détermination numérique et expérimentale de la pression de base chez le modèle de calibrage AGARD-B

Les résultats des mesurages de la pression de base chez le modèle de calibrage AGARD-B, effectués dans la soufflerie aérodynamique T-38 à l'Institut militaire technique, Serbie, sont présentés dans ce travail. La comparaison des diagrammes a démontré bon accord entre la pression de base mesurée dans la soufflerie aérodynamique T-38 et la pression de base mesurée dans la soufflerie aérodynamique IAR (NAE), Canada. Le programme aérodynamique numérique FLUENT est utilisé pour le calcul de la pression de base chez le modèle de calibrage AGARD, avec ou sans dard. Chez le même modèle la pression de base est déterminée par le programme de la dynamique semi empirique (DMAC et missile DATCOM) pour l'angle d'attaque zéro. La différence entre la pression de base calculée et mesurée est causée par l'influence du dard.

Mots clés: **aérodynamique expérimentale, dynamique des fluides, simulation numérique, pression de base, coefficient de pression.**