



**Viscous full-potential (VFP) method for
three-dimensional wings and wing-body
combinations**
**Part 3: Error messages, failures and
suggested remedies**



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**VISCOUS FULL-POTENTIAL (VFP) METHOD FOR THREE-DIMENSIONAL WINGS
AND WING-BODY COMBINATIONS
PART 3: ERROR MESSAGES, FAILURES AND SUGGESTED REMEDIES**

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VISCOUS FULL-POTENTIAL (VFP) METHOD FOR THREE-DIMENSIONAL WINGS AND WING-BODY COMBINATIONS

PART 3: ERROR MESSAGES, FAILURES AND SUGGESTED REMEDIES

1. INTRODUCTION*

This Data Item describes a viscous-coupled version, VFP, of the Full-Potential method, FP, which is associated with a series of Data Items^{1,2,3,4,5,6} dealing with three-dimensional wings and wing-body combinations. VFP is a CFD (computational fluid dynamics) method coded in FORTRAN for calculating the flow field about, and aerodynamic forces on, an isolated wing (denoted usually as a wing-alone) or a wing-body combination (denoted usually as a wing-body) in a subsonic freestream, including the effects of shock waves. VFP uses a relaxation process to solve finite-difference forms of the full nonlinear velocity-potential equation for the flow around the three-dimensional geometry. The VFP program was developed over a period of years at ARA, Bedford and RAE/DERA (now QinetiQ), Farnborough, and is made available by ESDU under the terms of an agreement with QinetiQ. Used originally on mainframe computers, VFP has provided valuable data in the design of a number of aircraft. With advances in computers, it has become possible to perform runs of VFP on a PC within a few minutes. One of the advantages of the VFP method is to provide a rapid process to produce valuable data to assess the aerodynamic qualities of wings as part of the design process. This version of the program provides an enhancement to this process with a coupled semi-inverse swept-tapered integral boundary-layer method by Ashill and Smith^{7,8}.

For the analysis of the aerodynamic characteristics of swept wings, it is often found convenient for high aspect-ratio cases to make the assumption that the flow is locally similar to that around an infinite yawed wing. The calculation of the boundary layer is thereby greatly simplified. A method of this type has been developed by Smith for calculating turbulent boundary-layers. This method, which is of the integral type is coupled to the flow solver using a semi-inverse⁹ scheme which allows the calculation of flows with small amounts of separation. The method also includes other improvements to the modelling of the boundary layer which become more important as separation is approached. These improvements include the allowance for 'higher-order' effects in the correction for normal stress terms, a revised shape-parameter relationship which is more suitable for flows with separation and an improvement in the accuracy of the skin friction and the shape parameter of the velocity profile at low local Reynolds number.

Additional features include the provision of an increment in momentum thickness at the transition point to allow for trip drag and the capability to calculate viscous flows over forward-swept wings.

This Item, Part 3 in the series dealing with VFP, lists VFP failures and flow error messages and offers suggestions and remedies. The validation of VFP results with experiment and comparisons with other methods are given in Part 1 (Reference 10). The guide for running VFP comprises Part 2 (Reference 11).

Section 2 presents the error messages output by VFP which can either take the form of an error number or text. Section 3 covers the possible remedies to overcome failure of the VFP program.

* Any items of Notation mentioned here are as defined in References 10 and 11.

2. MESSAGES OUTPUT BY VFP

When VFP fails it is usually terminated with an error number or a statement regarding the reason for the failure. Also, during the running of VFP, warning messages may be output indicating that particular parameters have failed to converge in a particular subroutine within the program. In those cases the calculation either continues with no adjustment or the relevant parameter is reset to a default value. Normally these warning messages are output either at the beginning of a new flow condition and will disappear after several viscous iterations but will continually appear during the calculation for cases with flow separation. When the warning messages start to become more regular it is an indication that the solution is about to fail.

Sections 2.1 to 2.3 list the possible failures that can occur during the mapping of the geometry and the flow calculation along with advice to remedy the problems. Note that some of the error numbers are missing as they were originally part of the code development and are therefore no longer applicable.

Following a failure, either during the mapping of the wing to the computational plane or during the flow calculation, it is important that any data written to output files **.mapout** and **.flow** are inspected. This will establish how far the calculation has progressed and will also help to establish the possible reason for the failure. One of the common reasons for failure is that the input data is read incorrectly due not following the fixed format requirements. Therefore it is always a good idea to check these values against those in the output files.

2.1 Error Numbers Output by the Map Program

For further details on the input data for the map program see Reference 2 (ESDU 02014).

- | | |
|----------|--|
| ERROR(2) | The value of JPRINT in the .MAP file must lie between 3 and M . |
| ERROR(3) | For a wing with a trailing-edge sweep the absolute difference between X_4 and the trailing-edge value at the wing tip has become zero or negative. Check the value of X_4 in the .MAP file. |
| ERROR(4) | For a wing with a leading-edge sweep the absolute difference between X_3 and the leading-edge value at the wing tip has become zero or negative. Check the value of X_3 in the .MAP file. |
| ERROR(5) | The chordwise difference between the wing trailing-edge and leading-edge grid lines has become zero or negative. Check the values of G1SECT and G2SECT in the .GEO file. |
| ERROR(6) | The streamwise difference between the wing trailing-edge and leading-edge extension grid lines outboard of the wing tip has become zero or negative. Check the values of X_3 and X_4 in the .MAP file. |
| ERROR(7) | The value of IMARK is less than 0 for the first control section of the .GEO file. The value should be either 0 or 1 for the first control section. |
| ERROR(8) | The leading-edge point during the mapping of the wing geometry into the computational plane cannot be found. Check the section details in the .GEO file. |
| ERROR(9) | The number of IDEL and NDEL values input exceeds the maximum value of 20. Check the .MAP file. |