SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP4191D

Issued 1989-07
Cancelled 2009-05

Superseding ARP4191C

Gas Turbine Engine Performance Presentation for Digital Computer Programs Using FORTRAN 77

RATIONALE

As ARP4191C contains information that was incorporated from AS681, the S15 committee decided to upgrade ARP4191C to AS4191. Therefore as AS4191 supersedes ARP4191C, it (ARP4191C) should be cancelled.

CANCELLATION NOTICE

This document has been declared “CANCELLED” as of May 2009 and has been superseded by AS4191. By this action, this document will remain listed in the Numerical Section of the Aerospace Standards Index noting that it is superseded by AS4191.

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1. SCOPE:

This SAE Aerospace Recommended Practice (ARP) provides a method for digital computer programs for gas turbine engine performance, steady-state or transient, performance to be written using the FORTRAN 77 Language.

When it is agreed between the program User and Supplier that a particular program shall be supplied in FORTRAN 77, it is recommended that this ARP be used in conjunction with AS681 for steady-state and transient programs.

This ARP also describes how to take advantage of the FORTRAN 77 CHARACTER storage to extend the information interface between the calling program and the engine subroutine.

The ARP has the same major section numbers as AS681 to facilitate its use with this document. The information given in each section of this ARP is additional to that given in AS681.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS681	Gas Turbine Engine Steady-State and Transient Performance Presentation for Digital Computer Programs
AS755	Aircraft Propulsion System Performance Station Designation and Nomenclature

3. GENERAL REQUIREMENTS:

3.1 Program Operation:

The program will have the capability of functioning both as a subroutine (herein called the engine subroutine) and as an independent program (consisting of a MAIN program containing a CALL statement to the engine subroutine).

4. PROGRAMMING PRACTICES:

4.1 Program Language:

'FORTRAN 77' when used in this document refers to ANSI X3.9 1978.

Fixed character data shall be held in the labeled CHARACTER COMMONS CHRIN and CHROUT.

The program may provide an extra text interface in the CHARACTER COMMON CHREXP which contains information that is not available from CHRIN or CHROUT. The storage defined in CHREXP is quite large and, therefore, use of CHREXP must be coordinated between user and supplier.

(See Section 6 for details of CHRIN, CHROUT and CHREXP).

5. PROGRAM CAPABILITIES:

5.1 Ram Pressure Recovery:

SERAM options 3, 5, and 6, which provide for a functional relationship between ram recovery and engine airflow and/or freestream Mach number, require a user supplied subroutine with the following call sequence:

CALL ERAMX (XM, WR*, SECALC, ERAM)

*W1R or W1AR as appropriate.

6. INPUT/OUTPUT:

6.1 Program Interface Definition:

6.1.1 The communication between the calling program and the engine subroutine will be handled completely by nine labeled COMMONS. These will be FIXIN, VARIN, EXPIN and CHRIN (character input) for input and FIXOUT, VAROUT, EXPOUT, CHROUT (character output), and CHREXP (extra character output) for output. The engine subroutine will never store computed values in FIXIN, VARIN, EXPIN, or CHRIN. Both INTEGER and REAL items in the common blocks have the length of a single precision full word. This restriction does not apply to character storage as it is independent of the length of a byte or word on any particular computer.

6.1.2 The fixed input parameters placed in labeled common FIXIN will be limited to the order and quantity defined in 6.2. The fixed output (FIXOUT) will be limited to the order and quantity of parameters defined in 6.3. If any parameter in the FIXIN or FIXOUT list is not used for a particular application, then that location in common will be unused so that the parameters which follow it may be found in the locations indicated in the tables. The remaining required input and output will be dependent on engine configuration and contained in labeled commons VARIN and VAROUT, respectively. Labeled commons EXPIN and EXPOUT will be reserved for additional parameters available through coordination between the program supplier and user.

6.1.3 The nomenclature utilized in the fixed input and output common blocks (FIXIN and FIXOUT) of 6.2 and 6.3 is for clarification only. Logically equivalent nomenclature consistent with AS755 is permitted, e.g., W1 may be substituted for W1A in FIXOUT when multiple streams have not been distinguished.

6.1.4 Some output parameters have corresponding inputs in FIXIN, where their names are prefixed by the letter Z. The output locations in FIXOUT should contain the values of each parameter as used in the computation, irrespective of whether they have been specified in the input or overridden by the program.

6.2 Input:

6.2.1 The Fixed Input Labeled Common Block FIXIN: The fixed sequence list of the parameters and the identity of these parameters (with typical nomenclature consistent with AS755) are as follows: (all parameters are REAL floating point numbers, except as indicated)

1. NIN	Input file number (INTEGER)
2. NOUT	Output file number (INTEGER)
3. IND	Engine program indicator (INTEGER)
4. thru 21.	Reserved for historical consistency
22. CASE	Numerical case identification
23. ZALT	Geopotential pressure altitude
24. ZDTAMB	Ambient temperature minus standard Atmospheric temperature
25. ZDT1A	Temperature to be added to T1A
26. ZERM1A	Ram pressure recovery at station 1A
27. ZPWXH	Customer high pressure rotor power extraction
28. ZPAMB	Ambient pressure
29. ZPC	Power code
30. ZPLA	Power lever angle
31. ZP1A	Engine inlet total pressure at station 1A
32. ZRC	Rating code
33. SERAM	Ram pressure recovery selection
	Average Options
	SERAM = 1, Selects specified ram pressure recovery
	SERAM = 2, Selects input value of ram pressure recovery
	SERAM = 3, Selects ram pressure recovery from user supplied subroutine (ERAMX)
	Differentiated Options

6.2.1 (Continued):

SERAM = 4, Selects input values of primary and secondary ram pressure recovery
SERAM = 5, Selects input value of primary stream ram pressure recovery and calls user supplied subroutine (ERAMX) for secondary stream ram pressure recovery
SERAM = 6, Selects primary and secondary stream ram pressure recoveries from user supplied subroutine (ERAMX)

34. SIM — Inlet Mode Selection
SIM = 1, Selects altitude and Mach number
SIM = 2, Selects pressure and temperatures
SIM = Other than 1 or 2 coordinated between user and supplier
35. ZTAMB — Ambient temperature
36. ZT1A — Engine inlet total temperature at station 1A
37. ZWB3 — High pressure compressor discharge bleed flow rate
38. ZWB3Q — High pressure compressor bleed flow ratio (discharge over component inlet)
39. ZXM — Free stream Mach number
40. ZERAM1 — Primary stream ram pressure recovery
41. ZERM11 — Secondary stream ram pressure recovery
42. -- — Reserved for historical consistency
43. -- — Reserved for historical consistency
44. -- — Reserved for historical consistency
45. -- — Reserved for historical consistency
46. SDIST — Inlet pressure and temperature distortion selection
47. FYPH — Primary maximum response frequency
48. FYSH — Secondary maximum response frequency
49. ZPWSD — Specified shaft power
50. ZTIME — Time from start of transient case
51. TIMEF1 — Time at which frequency is changed to FYSH
52. TIMEF2 — Time at which frequency reverts to FYPH
53. TIMEO — Output time interval
54. ZTIMET — Termination time of transient case
55. ZXJPTL — Polar moment of inertia of power turbine load
56. ZXNSD — Specified shaft rotational speed
57. ZTRQSD — Specified shaft torque
58. SWIND — Windmilling selection

6.2.2 The Variable Input Labeled Common Block VARIN: Will contain input dependent on engine configuration.

6.2.3 The Expanded Input Labeled Common Block EXPIN: Will contain input available through coordination between program supplier and user.

6.2.4 The Character Fixed Input Labeled Common Block CHRIN: Will contain

1. CTITLE User Title - CHARACTER * 72

6.3 Output:

6.3.1 The Fixed Output Labeled Common Block FIXOUT: The fixed sequence list of the parameters and the identity of these parameters (with typical nomenclature consistent with AS755) are as follows: (all parameters are REAL floating point numbers except as indicated).

1. thru 42. Reserved for historical consistency
43. thru 52
NSI (1) thru
NSI (10) Numerical Status Indicator (DIMENSION 10 INTEGER).
53. AE8 Primary exhaust nozzle throat effective area
54. AE18 Bypass exhaust nozzle throat effective area
55. ANGBT Boat-tail angle
56. FRAM Ram drag
57. FG Gross thrust
58. FGI Ideal gross thrust
59. FG19 Bypass stream gross thrust
60. FGI19 Bypass stream ideal gross thrust
61. FHV Fuel lower heating value
62. FN Net thrust
63. PB3 High pressure compressor discharge bleed flow total pressure
64. P7 Primary exhaust flow total pressure
65. P17 Bypass exhaust flow total pressure
66. SFC Specific fuel consumption
67. -- Reserved for historical consistency
68. TB3 High pressure compressor discharge bleed flow total temperature
69. TC Control temperature (cockpit display)
70. T7 Primary exhaust flow total temperature
71. T17 Bypass exhaust flow total temperature
72. WFE Engine fuel flow rate
73. WFT Total fuel flow rate
74. W1A Engine inlet flow rate at station 1A
75. W7 Primary exhaust flow rate
76. W17 Bypass exhaust flow rate
77. W2 High pressure compressor inlet flow rate
(The full number representing the relevant station designation, e.g., W21, W215, W2A, will be defined by the program supplier.)
78. XNH High pressure rotor rotational speed
79. XNI Intermediate pressure rotor rotational speed
80. XNL Low pressure rotor rotational speed
81. XNSD Delivered shaft rotational speed
82. ALT Geopotential pressure altitude