AEROSPACE STANDARD	**AS755**	**REV. F**
	Issued 1962-11 Reaffirmed 2009-04 Revised 2014-12 Superseding AS755E	

(R) Aircraft Propulsion System Performance Station Designation

RATIONALE

Aircraft propulsion technology continues to evolve and advance to meet changing requirements and challenges for improved performance and capabilities. This continuing evolution leads to a growing complexity of station numbering schemes, which are presented in AS755. An industry desire to expand nomenclature descriptions has also emerged. To facilitate future expansion of these standards, a decision was been made to divide the "station numbering" and "nomenclature" contents of AS755 into separate documents. AS755 will continue to maintain standards for station numbering. A new SAE Aerospace Standard, AS6502, will maintain standards for classical nomenclature moving forward. Both documents will continue to be revised and expanded as industry needs dictate.

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1. SCOPE

1.1 This SAE Aerospace Standard (AS) provides a performance station designation system for aircraft propulsion systems and their derivatives.

1.2 The station numbering conventions presented herein are for use in all communications concerning propulsion system performance such as computer programs, data reduction, design activities, and published documents. They are intended to facilitate calculations by the program user without unduly restricting the method of calculation used by the program supplier.

1.3 The contents of this document were previously a subset of AS755E. Due to the growing complexity of station numbering schemes and an industry desire to expand nomenclature descriptions, a decision was made to separate the “station numbering” and “nomenclature” contents of AS755 into two separate documents. AS755 will continue to maintain standards for station numbering. SAE Aerospace Standard AS6502 will maintain standards for classical nomenclature moving forward. Both documents will continue to be revised and expanded as industry needs dictate.

1.4 Numbering conventions for instrumentation used in testing aircraft propulsion systems are not explicitly addressed in AS755. Other industry resources, such as ARP246, AIR1419, and AGARD-AR-245, provide recommendations and guidance based on AS755 station numbering and AS6502 nomenclature principles.

2. APPLICABLE REFERENCES

The following publications form a part of this document 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 document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AIR1419 Inlet Total-Pressure-Distortion Considerations for Gas-Turbine Engines

ARP246 Orientation of Engine Axis, Coordinate and Numbering Systems for Aircraft Gas Turbine Engines

ARP5571 Gas Turbine Engine Performance Presentation and Nomenclature for Object-Oriented Computer Programs

AS6502 Aircraft Propulsion System Performance Nomenclature

2.2 ICAO Publications

Available from ICAO, Document Sales Unit, 999 University Street, Montreal, Quebec H3C 5H7 Canada, Tel: +1-514-954-8022, www.icao.int.

Doc 7488 International Civil Aviation Organization, Manual of the ICAO Standard Atmosphere

2.3 AGARD Publications

Available from National Technical Information Service (NTIS), 5301 Shawnee Rd., Alexandria, VA 22312, Tel: 703-605-6000 or 1-800-553-6847, www.ntis.gov.

AGARD-AR-245 Advisory Group for Aerospace Research & Development, Recommended Practices for Measurement of Gas Path Pressures and Temperatures for Performance Assessment of Aircraft Turbine Engines and Components

3. STATION DESIGNATION

The following station numbering system will be used to designate the points in the gas flow path that are significant to propulsion system performance definition.

For computer symbols in this document, the following convention will be used:

a. Ø denotes the numeric symbol

b. O denotes the alphabetic symbol

3.1 Basis of System

As flexible as the numbering method described in the following sections is intended to be, it cannot cover all conceivable configurations. For those systems that do not fit, the developer is encouraged to follow the basic conventions described here as much as reasonably possible. The goal should be to establish a clear numbering scheme that is consistent with the spirit of this standard.

The system provides for the consistent definition of the main thermodynamic processes acting on the gas, regardless of the type of engine cycle. The six main processes specifically isolated are:

a. kinetic compression (inlet/diffuser)

b. mechanical compression/work addition/fluidic compression (compressor/propeller)

c. combustion/heat addition or exchange (combustor/augmentor/heat exchanger)

d. mechanical expansion/work extraction (turbine)

e. mixing (mixer/ejector/eductor)

f. kinetic expansion (nozzle)

3.2 Primary Stream

The station numbers required to identify the process boundaries in the primary gas flow are:

Ø Free stream air conditions

1 First station of interest to the engine manufacturer, e.g., propulsion system entrance, external/internal interface, or vehicle/engine interface

2 First mechanical compression stage entrance

3 Last compression stage discharge or combustion entrance

4 Combustion discharge or first mechanical expansion / work extraction stage entrance

5 Last mechanical expansion / work extraction stage discharge

6 Mixing / ejection / eduction / afterburning entrance

7 Kinetic expansion entrance

8 Kinetic expansion throat

9 Kinetic expansion discharge

Figure 1 schematically illustrates the association of primary stream station numbers with the six main thermodynamic processes.

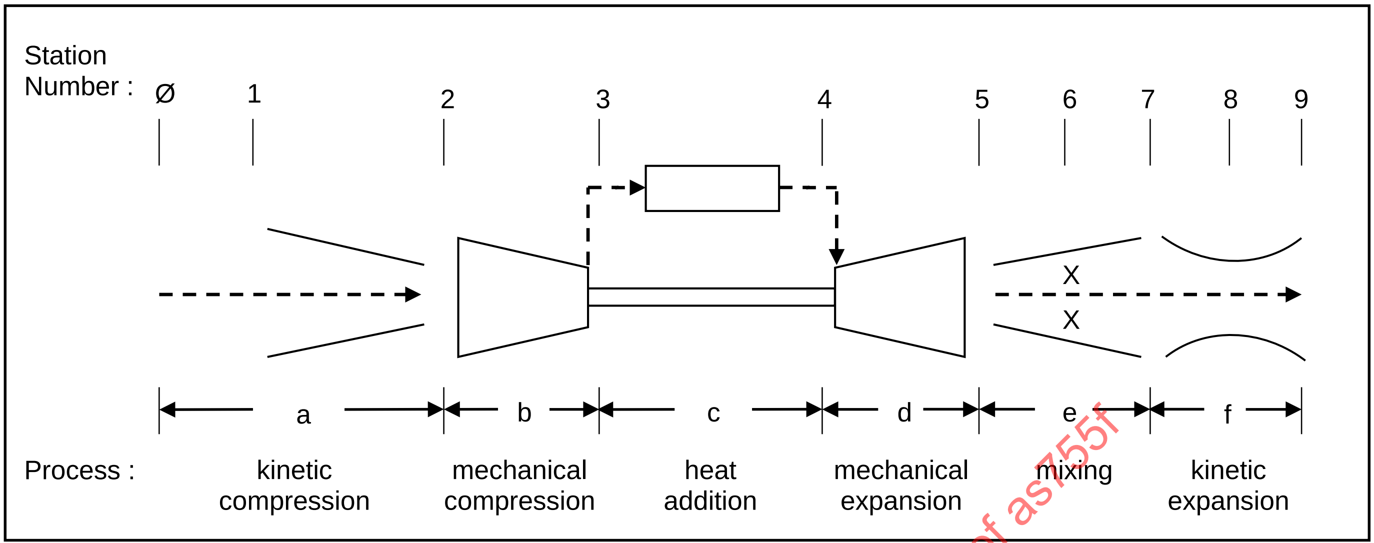


Figure 1 - Schematic association of primary stream station numbers and processes

Station numbers associated with missing processes should be eliminated. Numbers associated with the main thermodynamic processes identified in 3.2 should not be utilized for other processes. Under some circumstances it may be desirable for clarity to number these process-indicating stations as 1Ø, 2Ø, 3Ø, etc., or 1.Ø, 2.Ø, 3.Ø, etc. See also 3.5.

3.3 Multiple Streams

Extension of the primary stream numbering scheme to multiple streams is obtained by prefixing a digit to the station numbers in 3.2. This numbering method applies to multiple flow streams such as bypass streams of a turbofan engine, auxiliary power unit secondary flow streams, and other non-primary or auxiliary flow streams. A Ø may be prefixed to the primary stream if desired. See also 3.5.

3.3.1 Unity (1) will be used for the innermost multiple stream with each successive stream numbered in consecutive order to the outermost stream.

Examples: 12 First bypass stream, first compression stage entrance (if different from Station 2)
13 First bypass stream, last compression stage discharge
28 Second bypass stream exhaust nozzle throat

3.3.2 The consecutive numbering method for multiple bypass streams is the standard convention. The previous practice of using a leading digit 9 to identify the second bypass stream and a digit 8 for a third bypass stream, etc., is no longer recommended.

For situations which may be ambiguous or confusing, refer to the alternate numbering system described in 3.5.

3.3.3 The numbering method of 3.3.1 presumes concentric flow streams. Non-concentric streams may be numbered in their order of branching from the primary stream or in some other logical manner.

3.3.4 The multiple stream numbering method may also be applied to intermediate processes (see 3.4) or streams which may occur at locations between the main thermodynamic processes (e.g., a secondary flow process, or bypass duct heater), and to processes which may occur outside of the flowpath streams (e.g., an external heat exchanger).

3.3.5 If two or more flow streams are mixed, successive numbers will be consistent with the inner or lower numbered stream. For example, primary stream numbers are to be used when primary flow is mixed with a bypass flow.

3.3.6 For flow streams which have multiple functions (e.g., variable cycle engines), variable stations may retain station numbers across operating modes, or switch with operating mode as preferred by the developer. In either case, the basic numbering method of 3.3.1 is to be maintained when possible.

3.3.7 The first digit of the primary stream and the first two digits of additional streams will be numeric only.

3.3.8 Property values for individual streams are always average and mass flows are always sum total quantities.

Where primary and bypass streams are differentiated by separate stations and there is a need to describe the average (or sum total) properties at a plane including both streams, an alphanumeric station will be created. This station will be coplanar with the primary and bypass stations and formed by appending a letter to the primary station identification.

Appending the letter A (e.g., 1A) is reserved to describe the average properties or sum total flow of all the streams in that plane. For example, when stations 1 and 11 define the primary and bypass streams at the engine inlet interface, station 1A is defined as encompassing both stations 1 and 11. More than two streams can be handled in a similar manner.

3.4 Intermediate Stations

For identification of intermediate stations, numeric or alphabetic subdividers (if necessary) will be appended to the upstream station numbers in 3.2 and 3.3. The appended subdivider should, where possible, be limited to one additional digit which will be chosen to prevent duplication, and will be assigned in an ascending or alphabetic sequence which corresponds to the direction of flow.

When using numeric subdividers, the use of a decimal point separator is encouraged to avoid confusion with multiple stream designators. The use of a decimal point may be incompatible with some computer languages. In such a case, it may be omitted or replaced by some other distinguishable character. A station between a primary stream low and high pressure compressor could be shown as 2.5 (preferred), 25, 2_5 or 2$5 for instance. Also see 3.5 for an alternate numbering method which eliminates the need for separators.

If the length of the station designator is restricted so as to make the use of a separator character undesirable, an alphabetic subdivider is appropriate for multiple stream propulsion systems. For example, a primary intermediate station between stations 1 and 2 for a bypass engine may be identified as 1B to avoid conflict with the innermost bypass duct first compression stage entrance, station 12. This approach can however introduce ambiguity. See 3.5 for an alternate approach which reduces potentially ambiguous station numbers.

3.5 Alternate Numbering System for Reduced Ambiguity

As indicated, the station numbering system described in the preceding paragraphs can potentially lead to ambiguous station numbers. For example, 28 could be the exhaust nozzle throat of the second bypass flow stream, or it could be a station intermediate between 2 and 3 in the primary flow stream.

The following modifications to the system eliminate most if not all potential ambiguity in station numbering. In addition to the rules of 3.2 to 3.4, apply the following principles:

a. Always use the first digit of the station number to indicate “stream”, including explicitly using Ø for the primary stream.

b. Always use the second digit of the station number to indicate “process” per 3.2.

c. Third and subsequent digits indicate intermediate stations. Use of a trailing Ø on the station numbers of 3.2 is recommended.

d. Note that following these principles results in station numbers of three or more digits, with an implied decimal point after the second digit. The objective, however, is to eliminate the use of decimals with the alternate system.

e. The only exception to the use of multiple digits is station Ø (free stream), which remains a single digit

Examples:

Ø3Ø	Primary flow stream, last compression stage discharge/ combustion entrance
Ø25	Primary flow stream, station intermediate between Ø2Ø and Ø3Ø
Ø252	Primary flow stream, station intermediate between Ø25 and Ø26
13Ø	First bypass flow stream, last compression stage discharge combustion entrance
48Ø	Fourth bypass flow stream, nozzle throat

3.6 Inlet Stations

At times there is a need to distinguish between “ram recovery” and additional losses that result from ducting downstream of the inlet proper. These losses may occur before the engine/vehicle interface, thus necessitating the addition of stations before station 1. These stations should append subdividers to the freestream station Ø and should follow the above guidelines.

3.7 Propeller Stations

Special considerations are involved for engines with propellers or propulsors. The engine manufacturer may not have responsibility for the propeller system. When data or cycle models are provided, the engine manufacturer may create station numbers without regard to the propeller. Propeller stations may, therefore, be distinct from those of the engine, while following the same general principles.

Propeller station designations should conform to the rules used for engines, but may contain the suffix "P". The propeller upstream station thus becomes 12P. For that portion of the airflow at the hub which also flows through the gas generator, the upstream station becomes 2P.

For intermediate stations in a counter-rotating propeller system, the station designations become 12xP and 2xP, respectively, where a numeral would be substituted for the embedded symbol "x". The downstream stations become 13P and 3P.

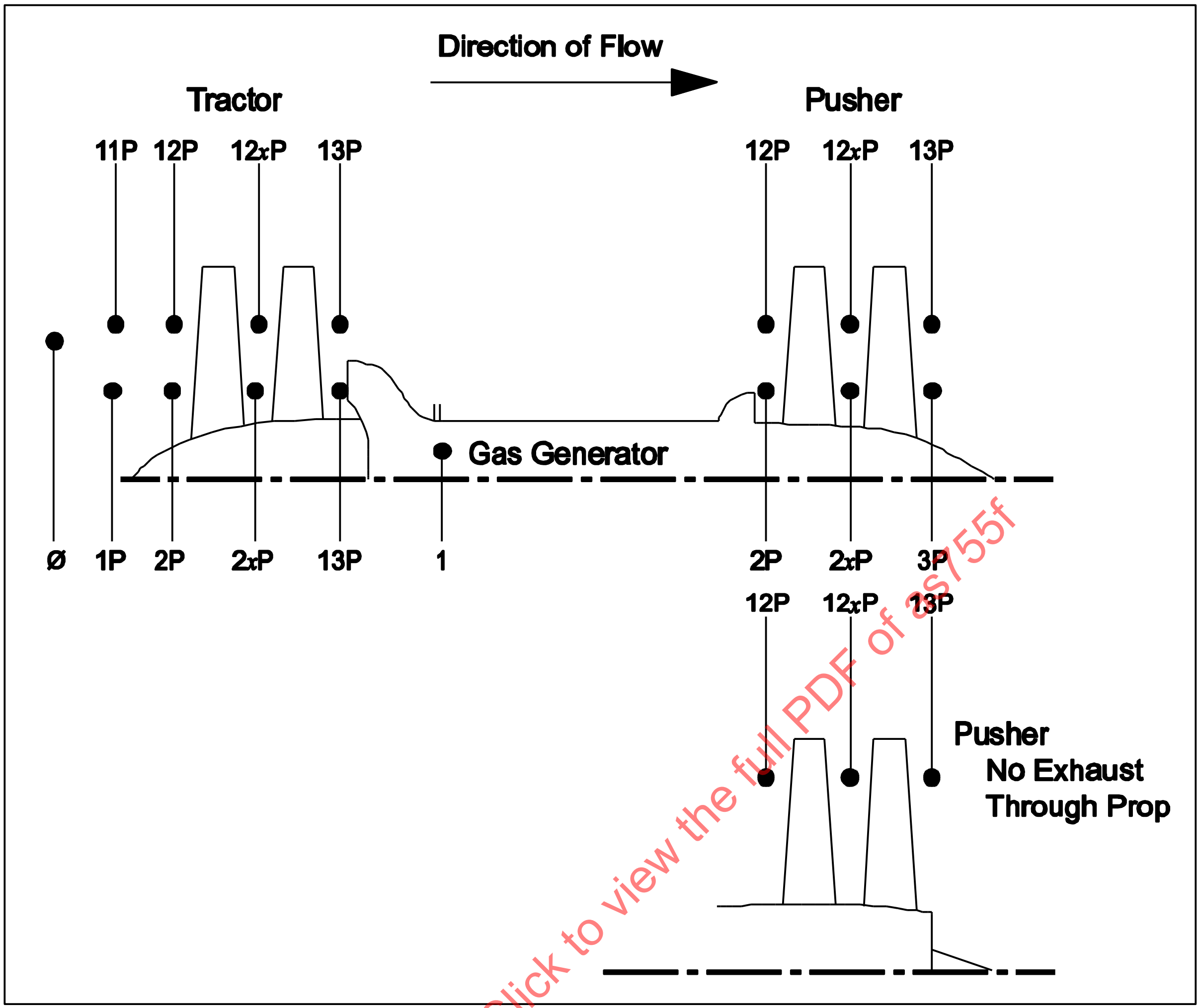
3.8 Rocket Stations

Special considerations are also involved for airbreathing powerplants which make use of rocket components, such as ducted rockets or ejector ramjets. One powerplant manufacturer may not have responsibility for the entire system. Rocket stations may therefore be distinct from those of the airbreathing portion of the system, while following the same general principles.

Rocket station designations should conform to the rules used for engines, but may contain the suffix RK.

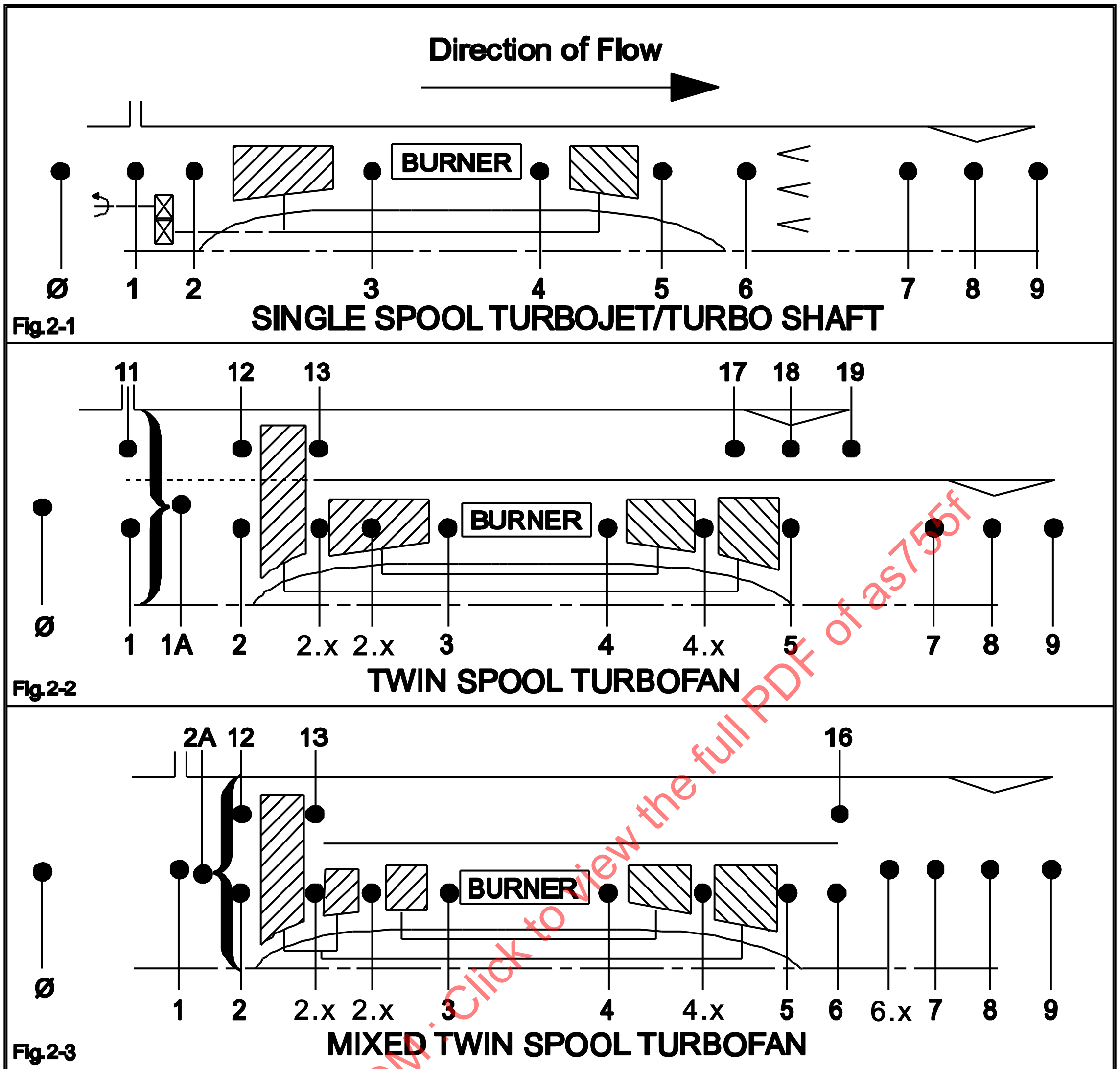
3.9 Figures

Figure 2 shows how the conventions of 3.2 to 3.4 may be applied to various pusher or tractor propeller systems. Figure 3 shows examples of the application of this system to several typical gas turbine engine configurations. Figure 4 shows examples of this system applied to other aircraft propulsion systems. Figure 5 provides examples of the alternate system of 3.5 applied to some of the configurations of Figure 3. Figure 6 shows an example of an intermediate station prior to the engine/vehicle interface, following the guidelines of 3.5 and 3.6.



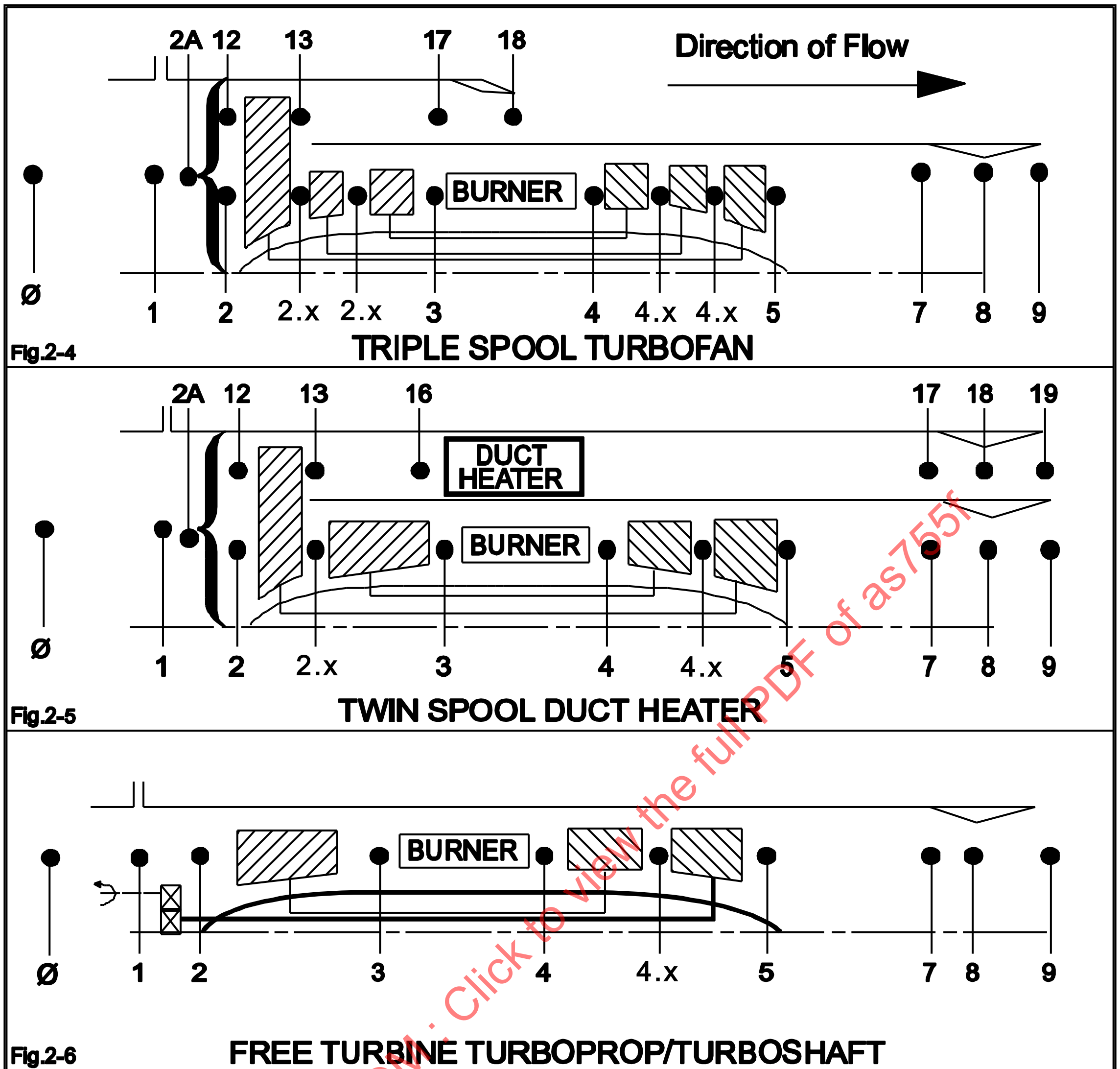
X = intermediate station (reference 3.7)

Figure 2 - Propeller/propfan/UDF/ultra-bypass/ultra-high bypass station designations (reference Section 3)



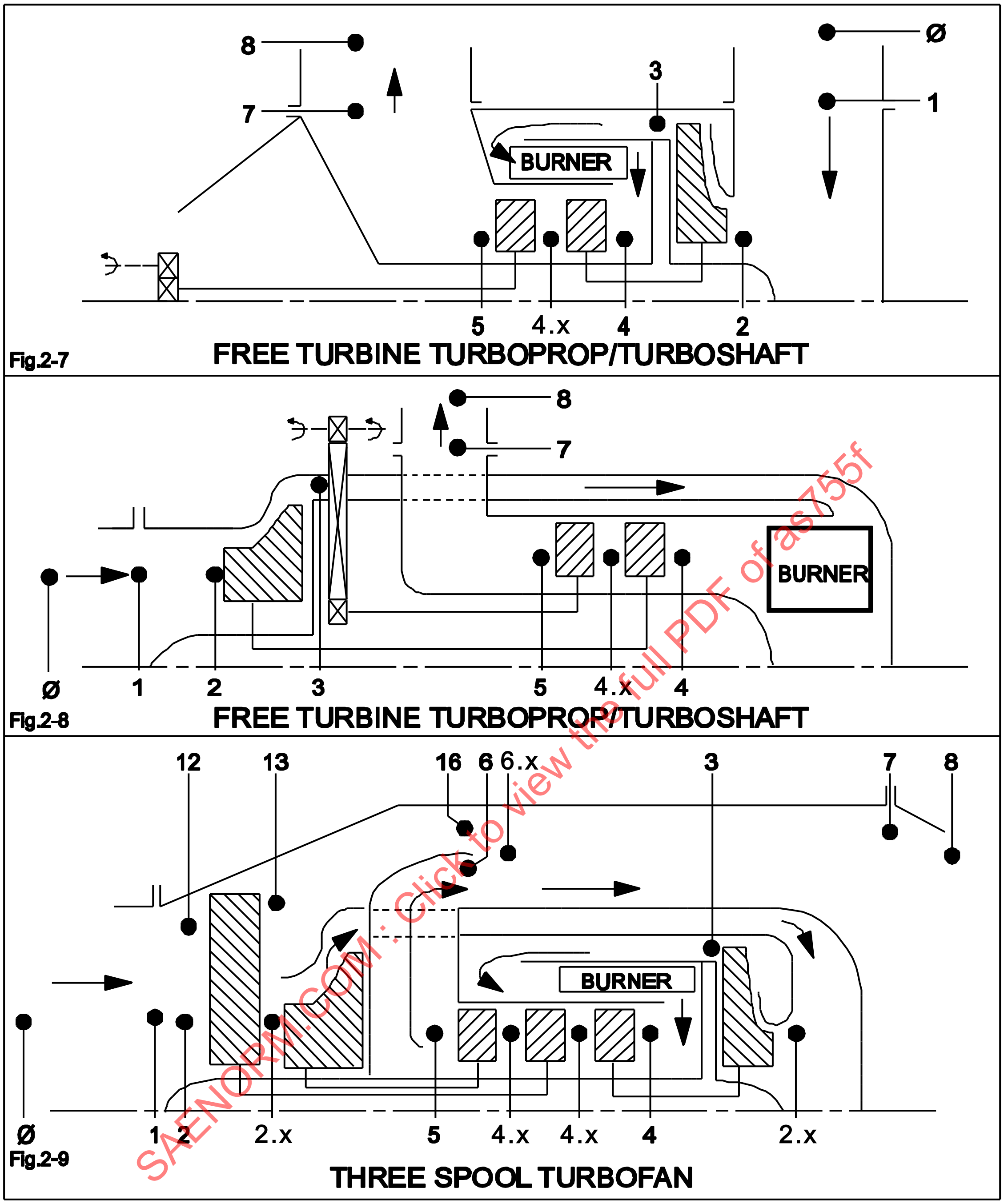
X = intermediate station (reference 3.4)

Figure 3 - Examples of station designation for gas turbine engines (reference Section 3)



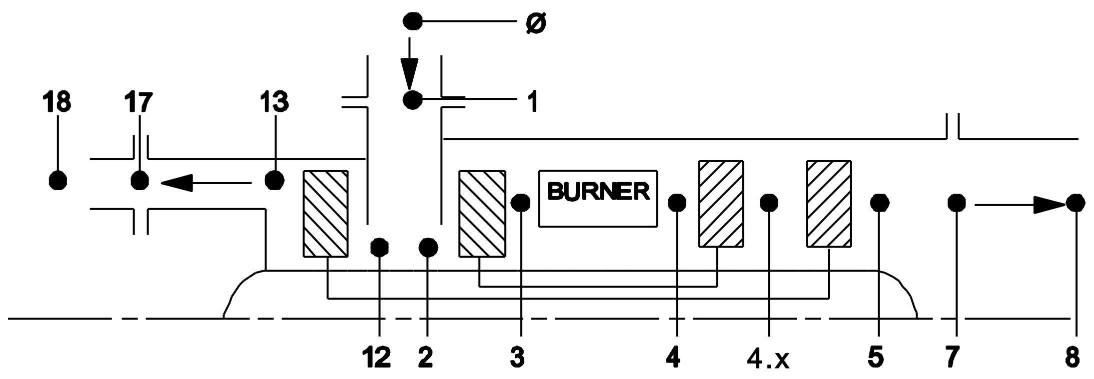
X = intermediate station (reference 3.4)

Figure 3 - Examples of station designation for gas turbine engines (reference Section 3) (continued)



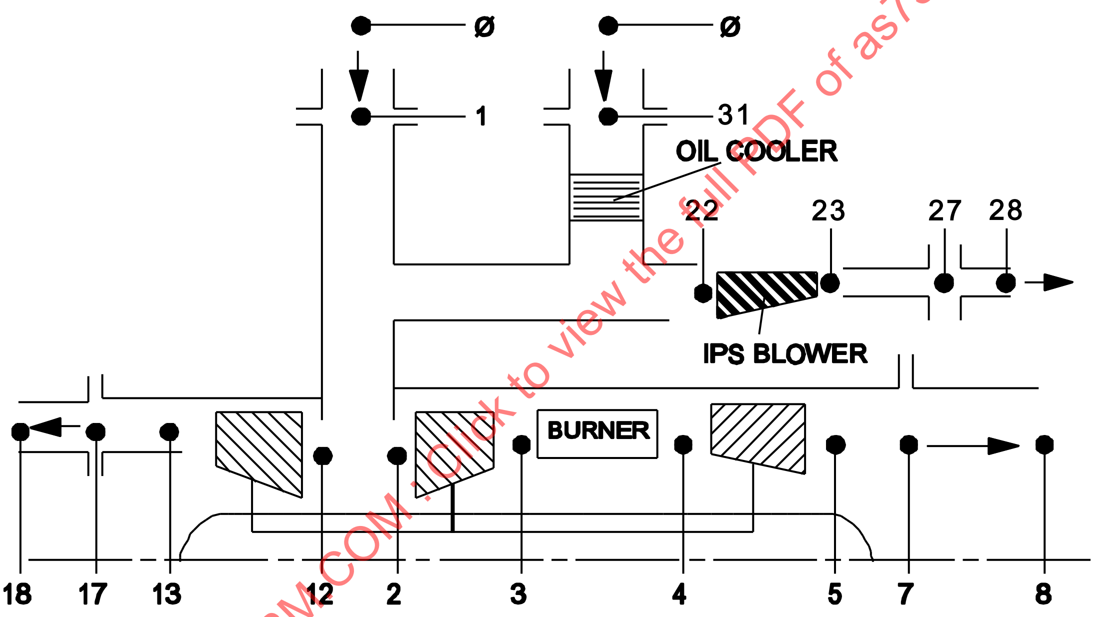
X = intermediate station (reference 3.4)

Figure 3 - Examples of station designation for gas turbine engines (reference Section 3) (continued)



AUXILIARY POWER UNIT
(Independent secondary compressor drive)

Fig.2-10

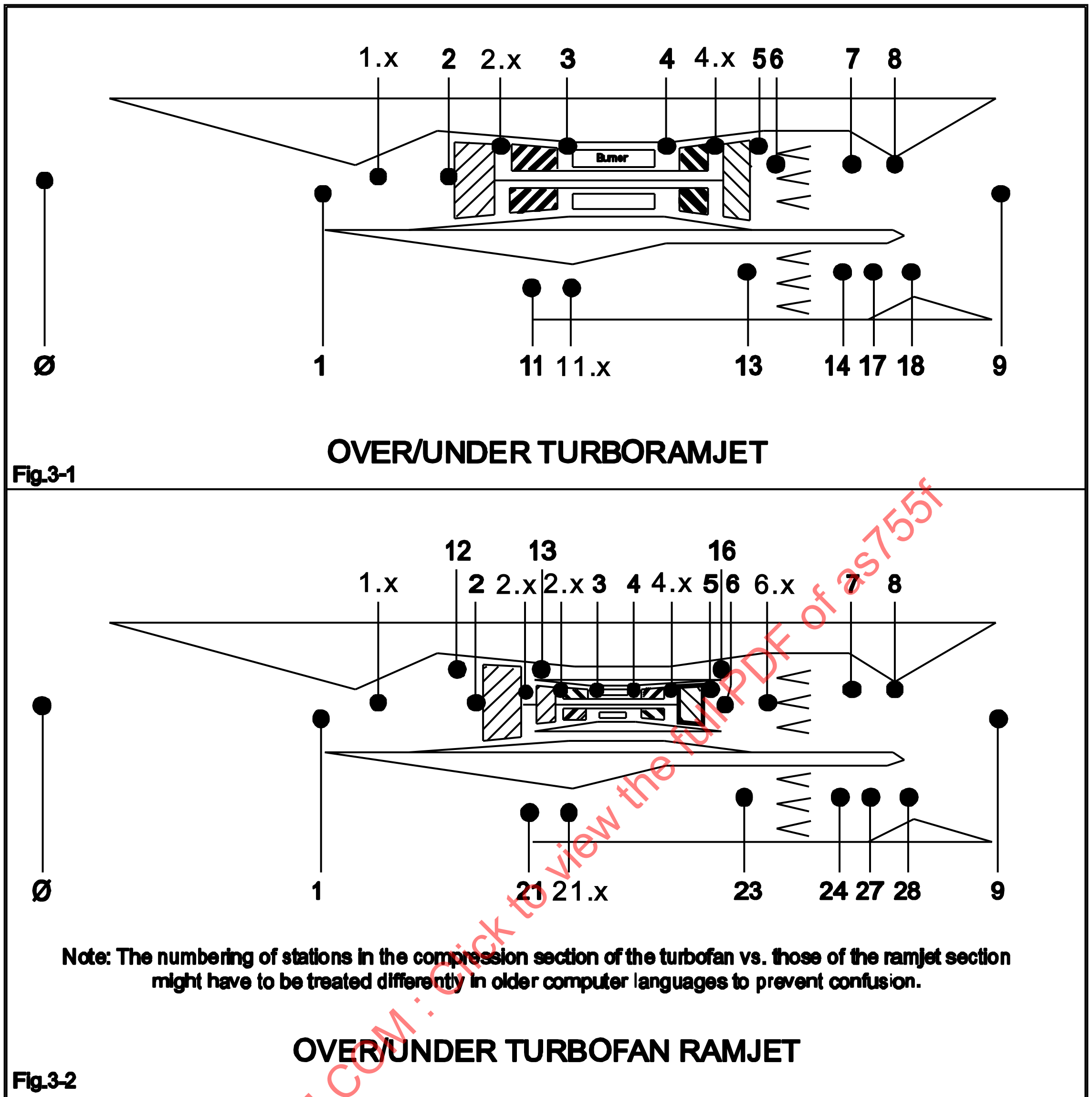


AUXILIARY POWER UNIT
WITH 2 STREAM INLET PARTICLE SEPARATOR

Fig.2-11

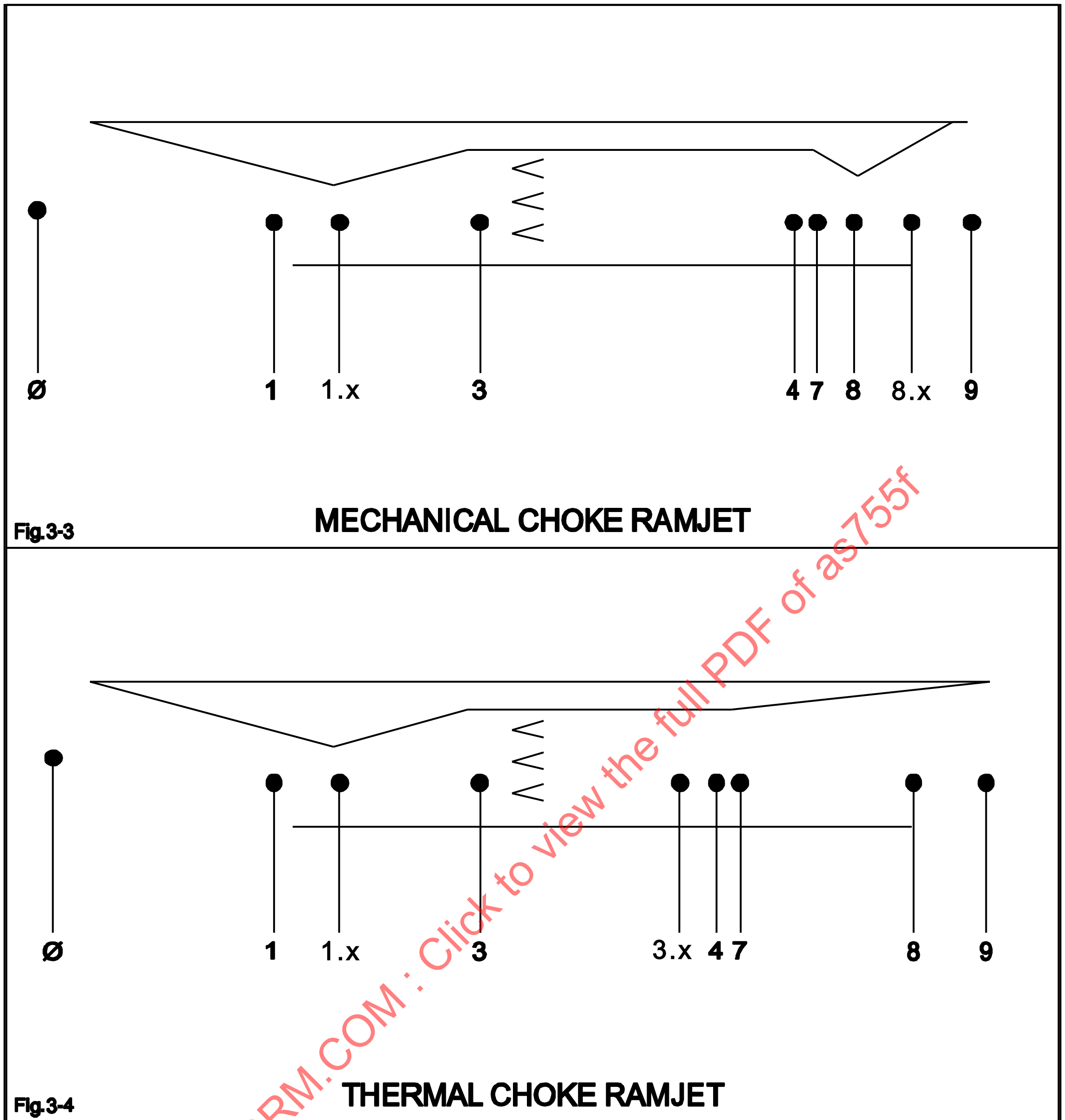
X = intermediate station (reference 3.4)

Figure 3 - Examples of station designation for gas turbine engines (reference Section 3) (continued)



X = intermediate station (reference 3.4)

Figure 4 - Examples of station designation for other airbreathing propulsion systems (reference Section 3)



X = intermediate station (reference 3.4)

Figure 4 - Examples of station designation for other airbreathing propulsion systems (reference Section 3) (continued)