AEROSPACE STANDARD	AS755™	REV. G
	Issued 1962-11 Reaffirmed 2009-04 Revised 2024-12 Superseding AS755F	

(R) Aircraft Propulsion System Performance Station Designation

RATIONALE

The continuous evolution of aviation propulsion leads to a corresponding growth in the complexity of station numbering schemes. To facilitate future expansion of these standards, “station numbering” and “nomenclature” have been separated into AS755 (numbering) and AS6502 (nomenclature). Both standards are under regular revision and expansion 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. REFERENCES

2.1 Applicable Documents

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.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (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

2.1.2 NTIS Publications

Available from National Technical Information Service, 5301 Shawnee Road, Alexandria, VA 22312, Tel: 1-888-584-8332 or 703-605-6050, 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

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR6508 Supplemental Propulsion System Performance Station Designation

2.2.2 ICAO Publications

Available from International Civil Aviation Organization, 999 University Street, Montreal, Quebec H3C 5H7 Canada, Tel: +1-514-954-8219, https://www.icao.int/.

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

3. STATION DESIGNATION

The station numbering system will be used to designate locations of thermodynamic significance to cycle performance.

For computer symbols in this document, the following conventions apply:

a. Ø denotes the numeric symbol

b. O denotes the alphabetic symbol

3.1 Basis of System

Although highly flexible, the numbering system prescribed herein cannot account for every possible architecture. For such systems, developers should conform insofar as they are able in light of project requirements. The goal is to minimize ambiguity by maximizing consistency.

This standard provides for consistent definition of the main thermodynamic processes acting on the working fluid, independent of engine cycle. The six thermodynamic processes of interest to this standard are (see Figure 1):

a. Kinetic compression (inlet/diffuser).

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

c. Combustion/heat addition or exchange (combustor/augmentor/heat exchanger). Heat flux is designated using the symbol $\dot{Q}$.

d. Mechanical expansion/work extraction (turbine).

e. Mixing (mixer/ejector/eductor).

f. Kinetic expansion (nozzle).

3.2 The Primary Gas Path

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, usually the 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

Prior to Revision G, this standard utilized one or two digit station assignments (see 3.8 and Figures 21 to 23.) The use of one or two digits remains acceptable, but, as of Revision G, it is considered legacy.

As of Revision G, a three-digit standard is prescribed (previous standards described this as an alternate scheme). The leading digit is used to unambiguously specify the stream of the referent station; the middle to specify process; the last to indicate intermediate locations. Although we refer to the characters in a station designation as "digits," it may be helpful to consider them as "bins." Revision G recommends the use of three of these bins, the first and last of which may contain more than one digit.

Utilize the following principles:

a. First digit (bin) indicates "stream," including explicitly using Ø for the primary stream.

b. Second digit (bin) indicates the process per 3.2.

c. Third digit (bin) indicates intermediate stations. Use of a trailing Ø to indicate a lack of intermediacy is recommended (e.g., "ØØØ" rather than "ØØ").

d. Although past versions allowed a decimal following the second digit, prefer printing sans decimal as of Revision G.

e. Previous revisions of this standard allowed an exception to the three-digit nomenclature for free-stream. Revision G removes this exception: free stream should be specified as "ØØØ."

EXAMPLES:
Ø3Ø Primary flow stream (0), last compression stage discharge/combustion entrance (30)
Ø25 Primary flow stream (0), station intermediate between Ø2Ø and Ø3Ø (25)
Ø252 Primary flow stream (0), station intermediate between Ø25 and Ø26 (252)
13Ø First bypass flow stream (1), last compression stage discharge combustion entrance (30)
48Ø Fourth bypass flow stream (4), nozzle throat (80)

This system does not explicitly debar a fourth digit for more precise location resolution (e.g., 0252 to indicate an intermediate station between 025 and 026). However, the opportunity for a fourth digit introduces potential ambiguity in cases where more than nine bypass streams are present. For example, station 1311 could be either the first bypass stream compressor exit, position 1, sub-position 1, or, the 13th bypass stream, vehicle interface, position 1.

To reduce ambiguity, AS755 recommends the use of an underscore, "_", for cases in which more than nine bypass streams are present. Thus, in the previous example, the 13th stream inlet, position 1, would be represented as: 13_11.

This means that, by standard, the stream number is always assumed to be a single digit, so that the fourth digit in a station number represents a position. If the stream number is more than one digit, the underscore must be present to clarify the meaning. Thus,

1311 is the 1st bypass stream (leading 1), compressor exit (3), station 1, sub-position 1.

13_11 is the 13th bypass stream (leading 13), inlet station (1), position 1 (no sub-position).

Station numbers associated with processes not present in the cycle should be omitted. Figure 1 illustrates the association of primary stream station numbers with the six main thermodynamic processes.

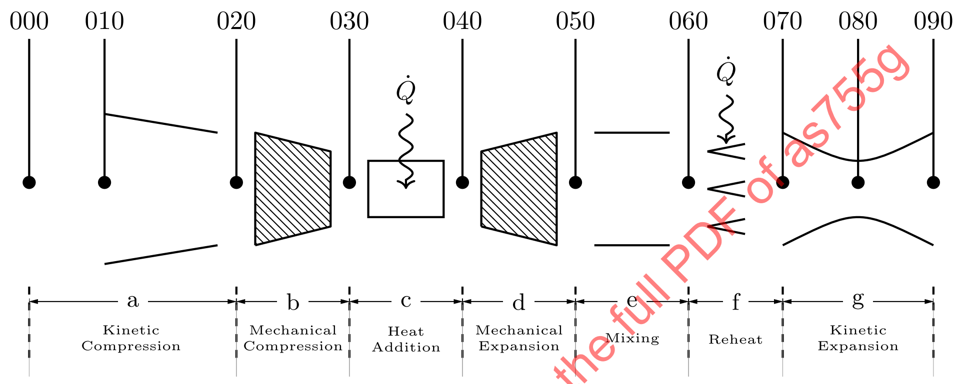

Figure 1 - Schematic representation of primary stream station numbers and processes

3.3 Multiple Streams

Architectures with a common concentric arrangement, wherein the bypass streams encompass a central core stream concentrically, should increment the stream number by one from core to outermost bypass. The core stream should always be stream zero.

EXAMPLES:
- 120 First bypass stream (1), first compression stage (2) entrance (0)
- 130 First bypass stream (1), last compression stage discharge (30)
- 280 Second bypass stream (2) exhaust nozzle throat (80)
- 10_21 Tenth bypass stream (10), compressor entrance (2), one position downstream of entrance (1)

Architectures with non-concentric streams should be numbered according to whatever seems most logical or expedient for communicating the necessary location information unambiguously (leaving the core stream numbered zero). For systems with more than nine secondary streams, an underscore will be used to separate the stream number from the process digit (see discussion in 3.2).

Revisions of this standard prior to G recommended a leading digit 9 to identify the second bypass stream and a digit 8 for a third bypass stream, etc. This is no longer recommended or necessary.

The stream numbering system may also be applied to intermediate processes or streams between the main thermodynamic processes (e.g., secondary flows), and to processes outside of the main flowpath streams (e.g., an external heat exchanger).

If two or more flow streams are mixed, numbering downstream of the mixer 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 (as though the bypass flow mixes into the primary flow and becomes part of the primary stream).

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 foundational stream numbering method is to be maintained when possible.

Property values for individual streams are always average; mass flows are always sums.

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 (which are not yet considered mixed), 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., 010A) is reserved to describe the average properties or sum total flow of all the streams in that plane. For example, when stations 010 and 110 define the primary and bypass streams at the engine-inlet interface, station 010A is defined as encompassing both stations 010 and 110. More than two streams can be handled in a similar manner (by appending a single letter to indicate the combination of all streams). This is separate and distinct from a mixing process – it applies only to streams which are not undergoing forced mixing, but need to be referenced where they converge at a plane.

3.4 Intermediate Stations

Previous versions of this standard permitted the use of a decimal to separate designations for intermediate stations – 4.1 for a turbine rotor inlet, for example. This is no longer recommended as of Revision G – 041 would be the correct designation in the present example.

3.5 Inlet Stations

At times, there is need to distinguish between “ram recovery” and other losses 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, e.g., ØØ1, as though they are intermediate stations. Consider Figure 24 as an example.

3.6 Propeller Stations

Special considerations are involved for engines with propellers or open-rotor propulsors. When data or cycle models are provided, the engine manufacturer may create station numbers without regard to the propeller if some other organization is responsible for propeller design. Propeller stations may, therefore, be distinct from those of the engine, but should follow 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 120P. For that portion of the airflow at the hub which also flows through the gas generator, the upstream station becomes 020P.

For intermediate stations in a counter-rotating propeller system, the station designations become 12xP and 02xP, respectively, where a numeral would be substituted for the embedded symbol “x.” The downstream stations become 130P and 030P. See Figure 8.

3.7 Rocket Stations

Special considerations are also involved for airbreathing powerplants which make use of rocket components, such as ducted rockets or integral rocket ramjets. Since responsibility for the entire system may be spread among multiple suppliers, the rocket stations may be distinct from those of the airbreathing portion of the system, but should follow the same general principles and be consistent with the airbreathing stations.

Rocket station designations should conform to the rules used for engines, but may contain the suffix "RK." Consider Figure 19.

3.8 Examples

Figures 2 through 20 exemplify application of AS755G for a wide range of cycle architectures. Figures 21 through 23 show the legacy one- or two-digit standard (pre-G revision). Figure 24 provides an example of an intermediate station prior to the engine/vehicle interface, following the guidelines of 3.5.

In each example figure, *x* is used to denote where a digit choice depends on designer preference, or on details unique to a specific application.

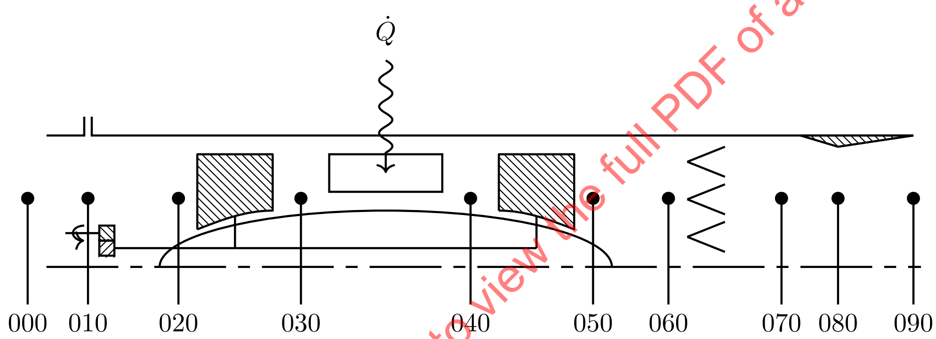

Figure 2 - Single spool turbojet/turboshaft

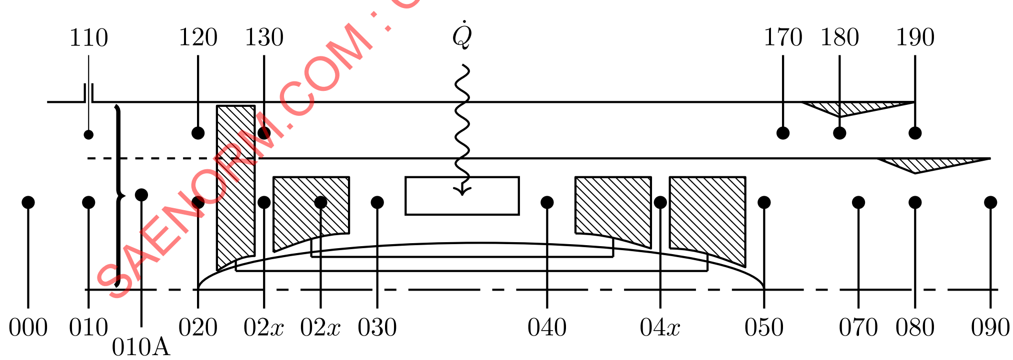

Figure 3 - Unmixed two-spool turbofan

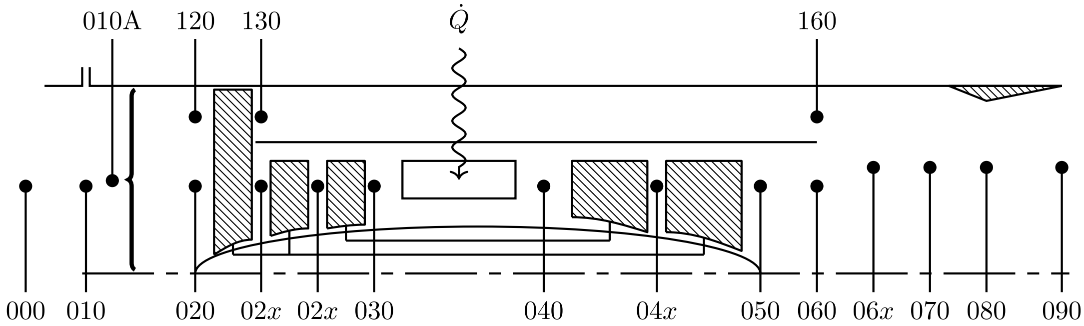

Figure 4 - Mixed two-spool turbofan

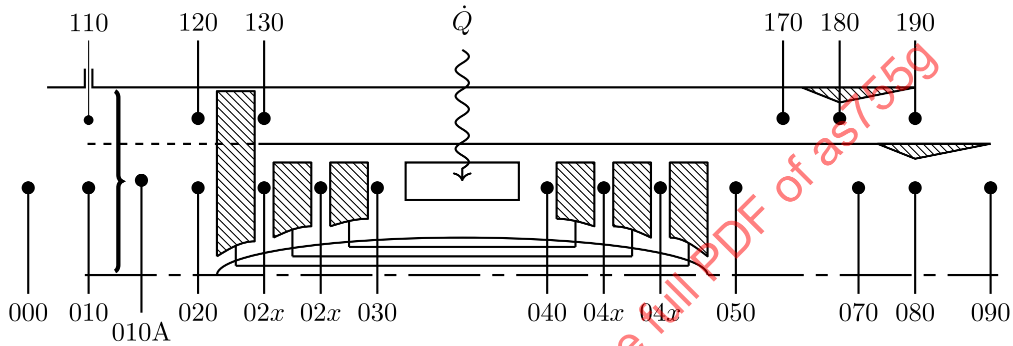

Figure 5 - Unmixed three-spool turbofan

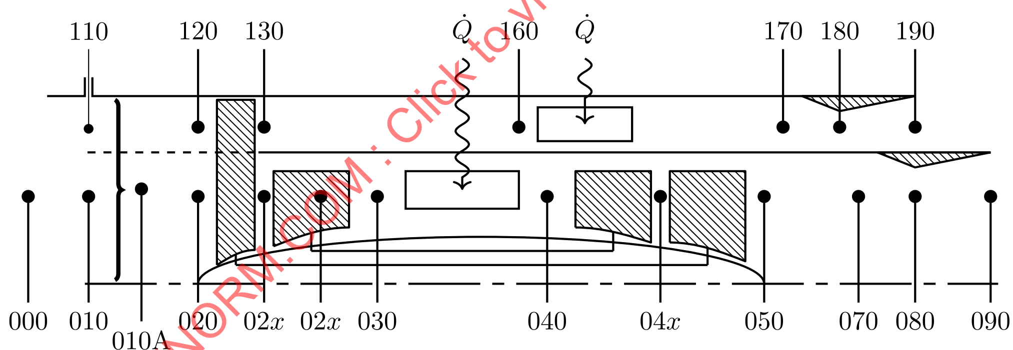

Figure 6 - Unmixed two-spool turbofan with a duct heater

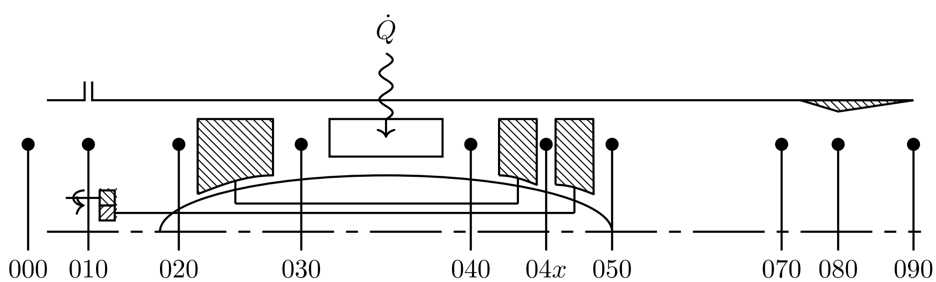

Figure 7 - Free-turbine turboprop/turboshaft

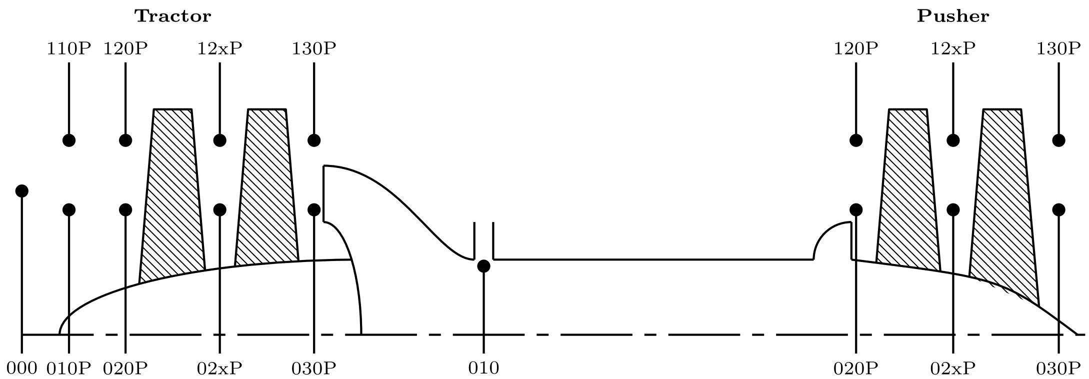

Figure 8A - Propeller/propfan/UDF/ultra-bypass/ultra-high bypass station designations – exhaust passes through pusher propellers

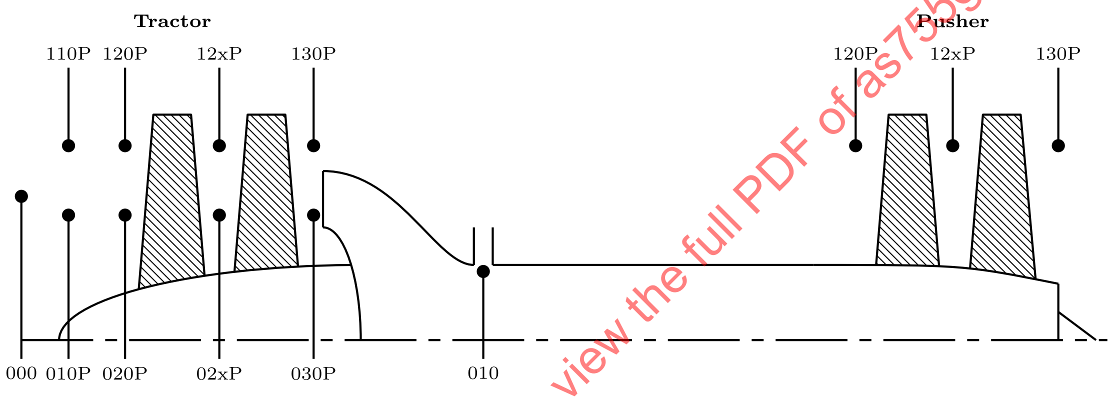

Figure 8B - Propeller/propfan/UDF/ultra-bypass/ultra-high bypass station designations – exhaust does not pass through pusher propellers.

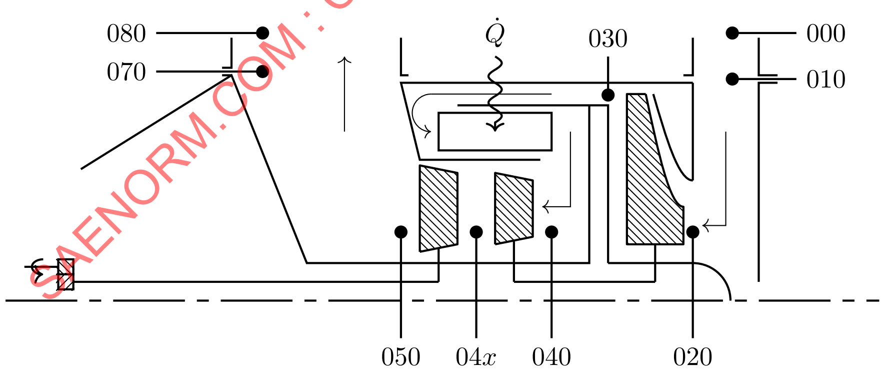

Figure 9 - Free-turbine reverse-flow turboprop/turboshaft

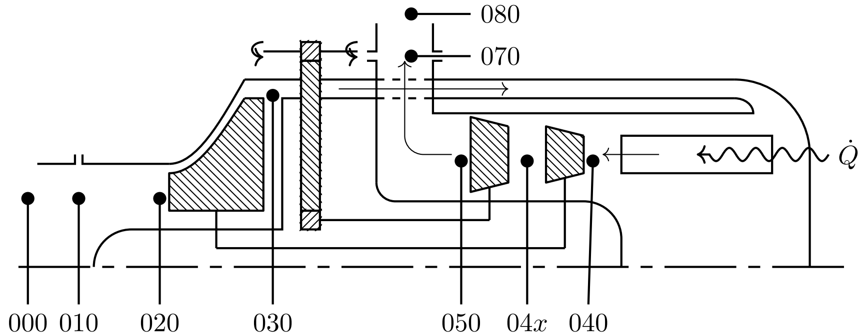

Figure 10 - Free-turbine turboprop/turboshaft with reverse-flow combustor

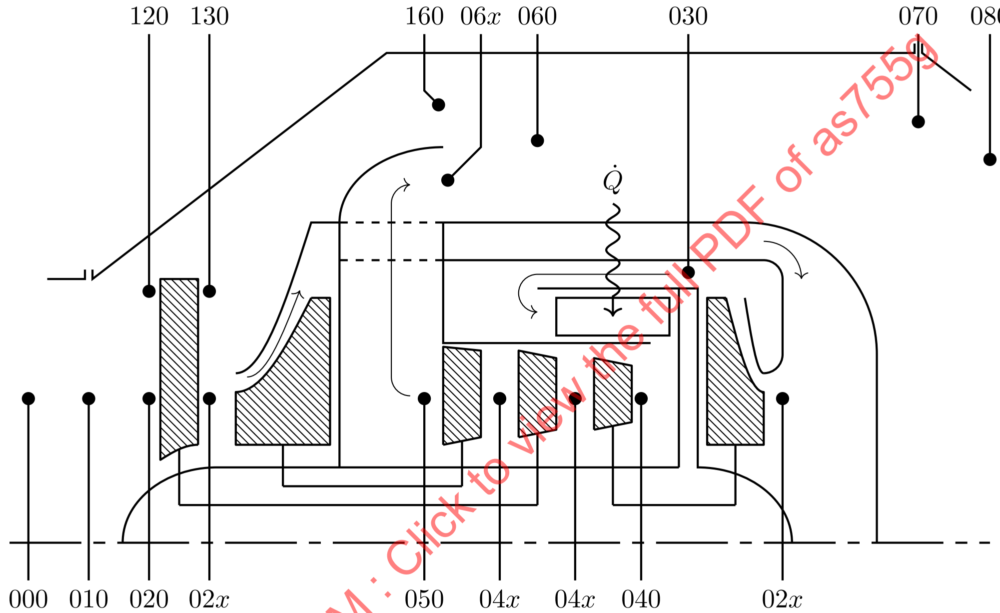

Figure 11 - Three-spool turbofan with reverse-flow core

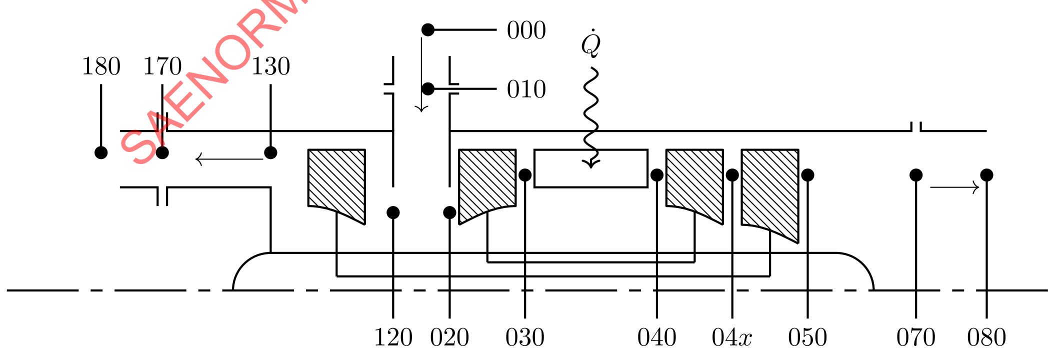

Figure 12 - Auxiliary power unit with independent secondary compressor drive

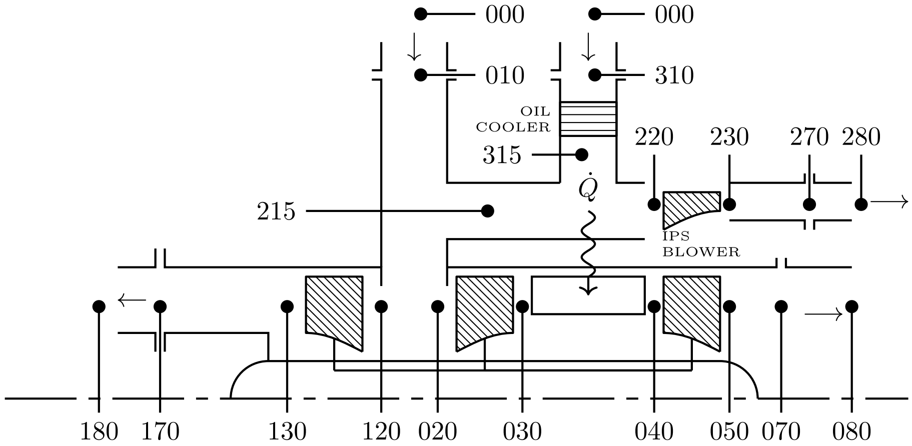

Figure 13 - Auxiliary power unit with two-stream inlet particle separator

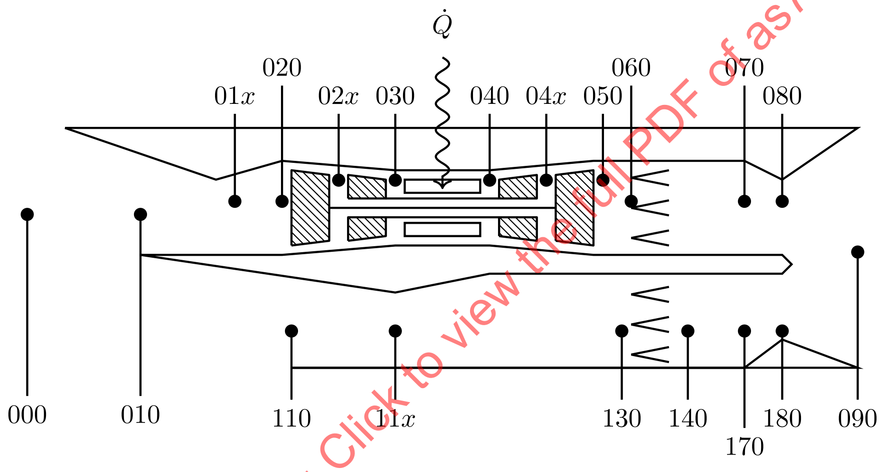

Figure 14 - Over/under turboramjet

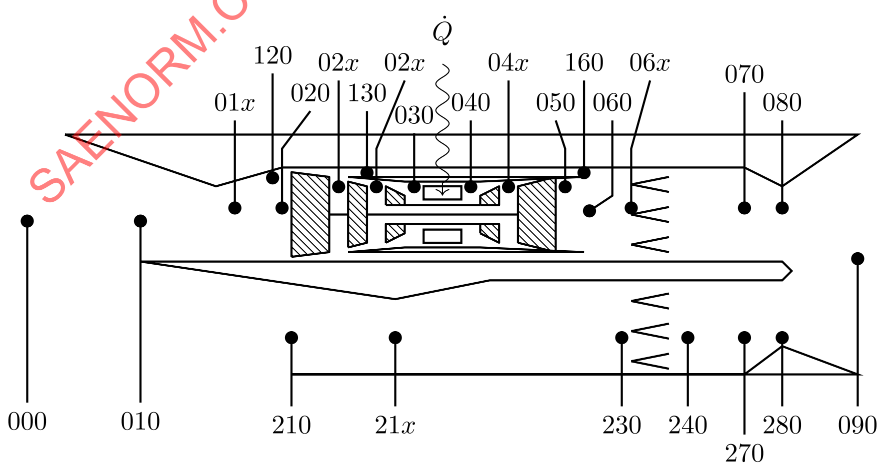

Figure 15 - Over/under turbofan-ramjet