# International Standard 4153

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# Aircraft — Pressure fuel dispensing system — Test procedure and limit value for shut-off surge pressure

*Aéronefs — Système de distribution de combustible sous pression — Méthode d'essai et valeur limite de la surpression*

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## Foreword

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International Standard ISO 4153 was developed by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and was circulated to the member bodies in February 1978.



It has been approved by the member bodies of the following countries :

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| Austria | Ireland | Spain |
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France
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# Aircraft — Pressure fuel dispensing system — Test procedure and limit value for shut-off surge pressure

## 0 Introduction

Shut-off of fuel flow by the aircraft fill control valves produces surge pressures. The surge pressures can be of magnitude great enough to damage the aircraft if the pressure fuel dispensing system lacks surge control devices, or if the aircraft fill control valves shut-off flow too abruptly. The purpose of this International Standard is to provide a standard procedure for testing the shut-off surge pressure of pressure fuel dispensing systems, and a limit value for the resulting surge pressure. Also, because both the test method and the associated limit value are standardized, necessary knowledge is provided for aiding proper design of the aircraft fill control valve shut-off characteristics.



## 1 Scope and field of application

This International Standard specifies a standard method for testing the shut-off surge pressure of pressure fuel dispensing systems, and a limit value for the resulting surge pressure. The specified method and limit value apply to all ground pressure fuel dispensing systems, fixed and mobile.



## 2 Procedure and limit value

### 2.1 Apparatus

#### 2.1.1 For systems with single dispensing line

Test apparatus as shown in figure 1 shall be connected at the dispensing system nozzle. The test adapter, line segments and valves shall have flow area at least equal to that of the dispensing system line. The length of the line segment between the adapter and the test shut-off valve (inlet line segment, item 4 in figures 1 and 2) shall not exceed 30 diameters. The test shut-off valve (item 6 in figures 1 and 2) shall be capable of closing within 0,5 s in a near linear manner. (See note 1 under 2.2.2.) It shall include means of enabling recording of its shut-off time with an accuracy of ± 5 %. To ensure that dispensing system flow is not abnormally restricted, the pressure drop of the test shut-off valve, in its fully open position, shall not be greater than that equivalent to 50 diameters of adjacent line. The pressure transducer (item 5 in figures 1 and 2) shall be connected to a high response, recording, pressure-measuring device, such as an oscillograph. The pressure transducer and recording measuring device shall have a suitable pressure range and its minimum frequency response shall be 600 Hz. It shall be verified by static pressure calibration that the error of the transducer and recording measuring device at 830 kPa (120 lbf/in$^2$ gauge) is not greater than 5 %.

The flow control valve (item 8 in figure 1) shall provide readily adjustable throttling and shall have a maximum pressure drop, in its fully open position, not greater than that equivalent to 50 diameters of adjacent line. The total length of the discharge line segments shall not exceed 50 diameters. (The functions of the test shut-off valve and the flow control valve may be combined in one device if the requirements stated for each are met.)

Flow rate shall be measured using the flow meter which is already part of the system. If the flow meter is a quantity meter rather than a rate meter, flow rate normally will be obtained by the "time rate of change of quantity" method. A rate meter may be installed in the system in place of the quantity meter for convenience; however, its resistance to flow shall not be greater than that of the quantity meter which it replaces. In all cases, the error for flow rate measurements shall not exceed ± 5 %.

Electrostatic bonding shall be provided for the system elements as necessary to eliminate sparking and fire hazard.

Also, initial start up of flow after connection of the test apparatus to the fuel dispensing system should be gradual to permit entrapped air to escape before high fuel flow rates are established through the test apparatus. This is because sudden transition from air flow to fuel flow through a restriction can produce high surge pressures.

#### 2.1.2 For systems with multiple dispensing lines

Test apparatus shall be as shown in figure 2. Requirements concerning the test apparatus shall be as stated in 2.1.1.

### 2.2 Test for system with single dispensing lines

#### 2.2.1 Preparation

Prior to commencing the surge test, it shall be verified that the dispensing system pressure regulator is adjusted to its prescribed no-flow pressure. With the test shut-off valve (item 6 in figure 1) in its fully open position, the flow control valve (item 8 in figure 1) shall be opened slowly until the flow rate through the dispensing system is the maximum obtainable. This shall be determined by repeated trial. During each trial, as nozzle pressure (shown by the gauge, item 1 in figure 1) is decreased by progressive opening of the flow control valve, the highest nozzle pressure at which the maximum flow rate occurs shall be

observed also. For the surge test, the flow control valve shall be opened just to the extent necessary to produce the maximum flow rate and nozzle pressure, found previously by trial. The maximum flow rate and the corresponding nozzle pressure shall be recorded.

NOTE — If flow rate continues to increase as nozzle pressure is decreased (by progressive opening of the flow control valve shown in the figure), rather than to stabilize at some maximum value (or automatically shut-off) before nozzle pressure falls below 242 kPa (35 lbf/in$^2$ gauge), the system shall be considered as not having flow-rate limiting mechanisms. Flow-rate limiting mechanisms, i.e., mechanisms which act only to prevent the exceeding of some prescribed maximum flow rate, are usually provided as a secondary control to the nozzle pressure control mechanism. For systems considered as not having such a flow-rate limit mechanism, the test flow rate shall be that flow rate which occurs when the nozzle pressure is reduced to between 234 and 242 kPa (34 and 35 lbf/in$^2$ gauge). The flow rate and nozzle pressure shall be recorded.

#### 2.2.2 Procedure

Subsequent to establishment of the maximum flow, close the test shut-off valve in 0,5 s or slightly less in a near linear manner. It is of benefit, in terms of surge pressure minimization, to utilize the full 0,5 s maximum allowed, and to shut-off the flow in a near linear manner. Record the test shut-off valve closing time and resulting peak surge pressure at the pressure transducer.

NOTES

1 The words "near linear manner" are used here to mean reduction of valve flow area at an approximately constant rate throughout the valve closure action. Such closure is of benefit and is recommended but not required. Closure time not exceeding 0,5 s is required.

2 The recorded surge pressure is essentially the sum of the steady state pressure existing before start of the valve closure and the transient pressure which results from destruction of flow velocity.

#### 2.2.3 Limit value

The maximum resulting surge pressure shall not exceed 830 kPa (120 lbf/in$^2$ gauge).

#### 2.2.4 Test report

For each test conducted, a complete written report shall be made describing the test apparatus, type of fuel, fuel temperature and fuel density in addition to the data required above. The test description shall include test valve, flow control valve, and instrumentation descriptions.

### 2.3 Test for system with multiple dispensing lines

#### 2.3.1 Preparation

Requirements shall be as stated in 2.2.1.

#### 2.3.2 Procedure

Conduct the test as described in 2.2.2 for the dispensing lines singly and in combination, i.e. with each line active alone and then with all lines active simultaneously. All lines need not be tested alone unless they differ significantly from one another. Inactivation of lines shall be by normal system means in order that the inactivated lines do not give abnormal surge absorption capacity to the system.



#### 2.3.3 Limit value

The maximum surge pressure shall not exceed 830 kPa (120 lbf/in$^2$ gauge).

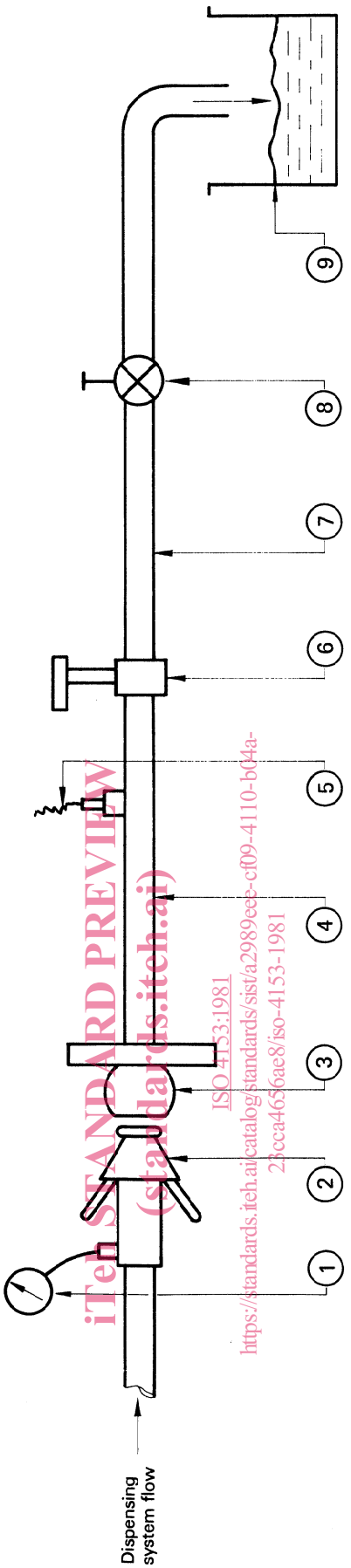


#### 2.3.4 Test report

Requirements shall be stated in 2.2.4.

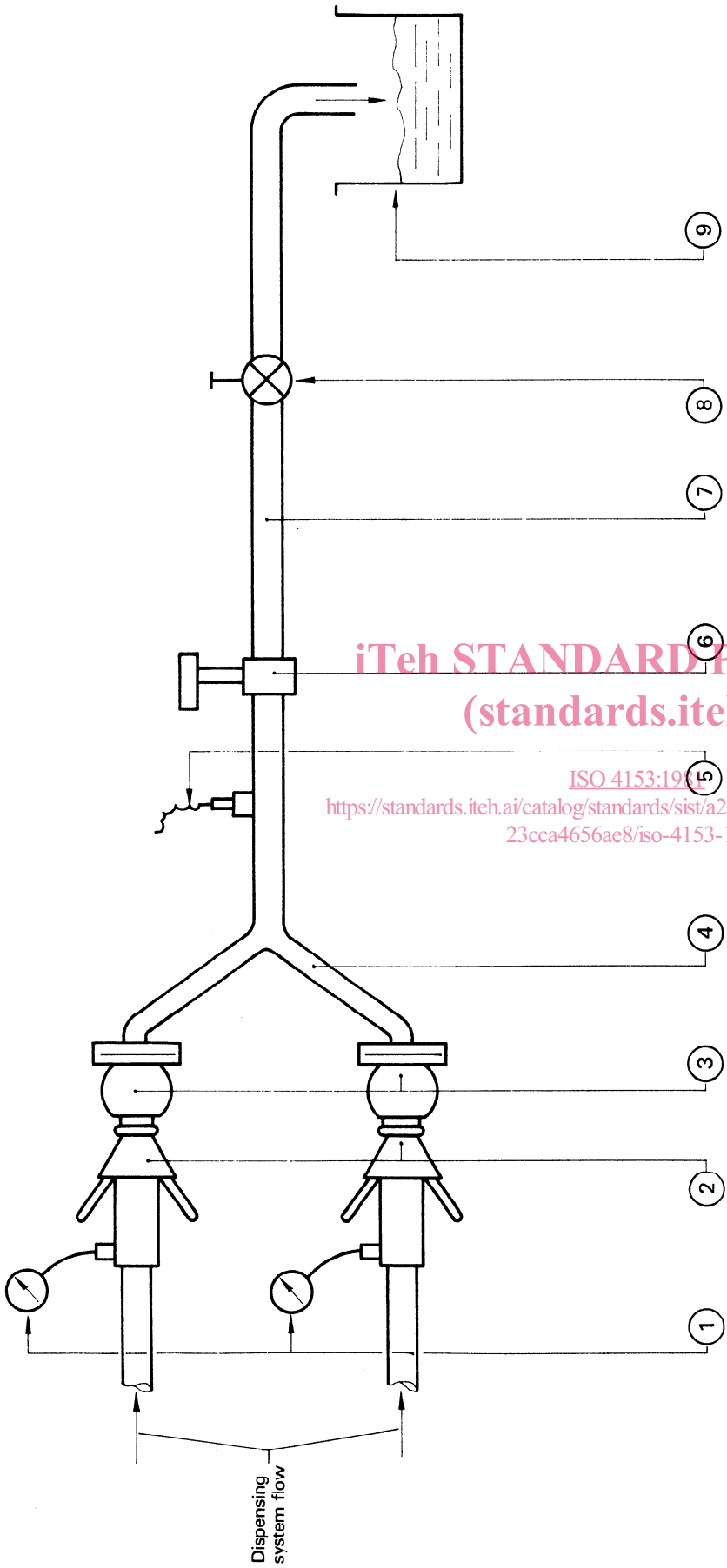
## 3 System changes

Changes or modification of the ground fuel dispensing system which could in any way increase its surge potential, such as increased line lengths, increase in pumping capacity, changes in flow control equipment, changes in pressure controller equipment or changes in system restriction, will require retesting in accordance with this International Standard.




① Pressure gauge
② Pressure fuelling nozzle
③ Adapter
④ Inlet line segment, metal only
⑤ Pressure transducer, connected directly to the line segment and bled of air
⑥ Test shut-off valve
⑦ Discharge line segment, metal only
⑧ Flow control valve
⑨ Catch tank

**Figure 1 — Single hose system**




NOTE — Items 1, 2 and 3 may be two or more depending on number of fuelling points in system being tested.

1 Pressure gauges
2 Pressure fuelling nozzles
3 Adapters
4 Inlet line segment, metal only
5 Pressure transducer, connected directly to the line segment and bled of air
6 Test shut-off valve
7 Discharge line segment, metal only
8 Flow control valve
9 Catch tank

**Figure 2 — Multiple hose system**

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