

McKenny Van

From: Larimore, Bryan [REDACTED]
Sent: Monday, March 26, 2012 10:05 AM
To: McKenny Van
Subject: FW: Turbmomeca reports - Tucson accident
Attachments: 471040.pdf; 471039.pdf

From: Larimore, Bryan
Sent: Thursday, March 22, 2012 8:18 AM
To: 'McKenny Van'
Subject: RE: Turbmomeca reports - Tucson accident

Good Morning Van,

Turbomeca authorizes the NTSB to place the reports attached here on the public side of the Official Investigation Docket.

Best regards,

Bryan

Bryan Larimore
Accident Investigation
TurbomecaUSA
office : [REDACTED]
fax : [REDACTED]

From: McKenny Van [REDACTED]
Sent: Friday, March 09, 2012 3:51 PM
To: Larimore, Bryan
Subject: Turbmomeca reports - Tucson accident

Bryan,

Both these TM reports have a proprietary statement on each page. Does the NTSB have permission to place these reports on the public side of the Official Investigation Docket? If so, I'll need some sort of written authorization, or copies of the reports without the proprietary statements.

Thanks,

VAN S. MCKENNY IV
Aerospace Engineer (Field)
National Transportation Safety Board
[REDACTED]

Arriel 2B1

Fuel main manifold supply pipe test

September 2010



Fuel main manifold supply pipe test

■ Purpose:

- The purpose of this test was to verify the behaviour of the fuel main manifold supply pipe and the jet union if incorrectly or not screwed on the intermediate casing flange.
- The test was carried on the prototype engine Arriel 2B1 S/N 42, representative of the Arriel 2B1 S/N 46268 configuration, at Turbomeca Bordes bench.

■ Configuration

- The engine was equipped with a specific tooling to avoid fuel projection on hot parts and installed around the union. No interaction between this tooling and the concerned parts.

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Fuel main manifold supply pipe test

■ Configuration

➤ A Pressure tapping point was introduced to measure the pressure inside the pipe (located between the start electro valve and the pipe support) the location of this tapping was chosen in order to not induce any stiffness to the pipe and had no impact on the pipe vibratory behaviour.

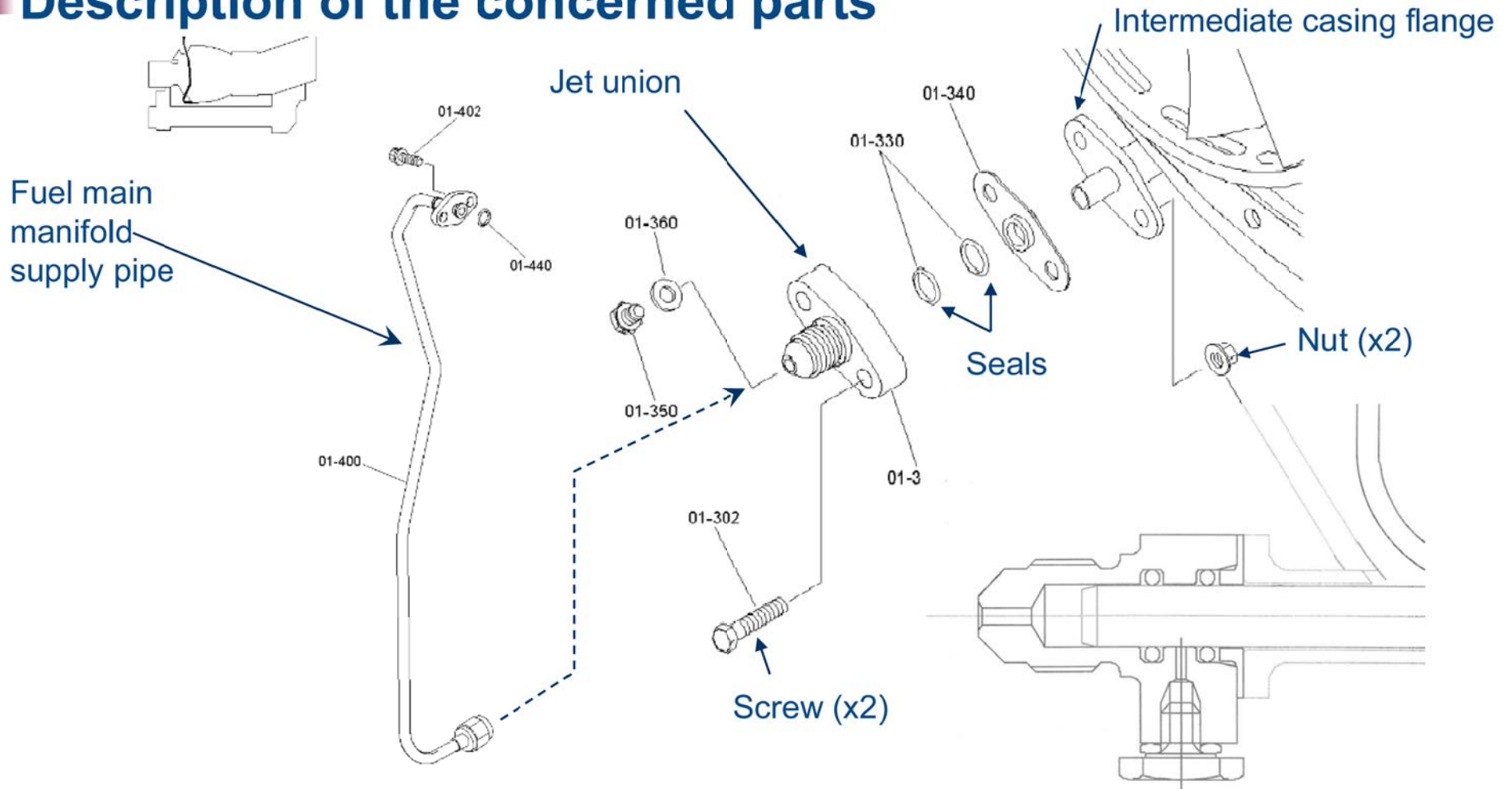
■ Note

- Our test was done on engine bench on 27th and 30th August 2010.
- This installation can not reproduce the environment of the aircraft (vibratory and thermal)

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Fuel main manifold supply pipe test

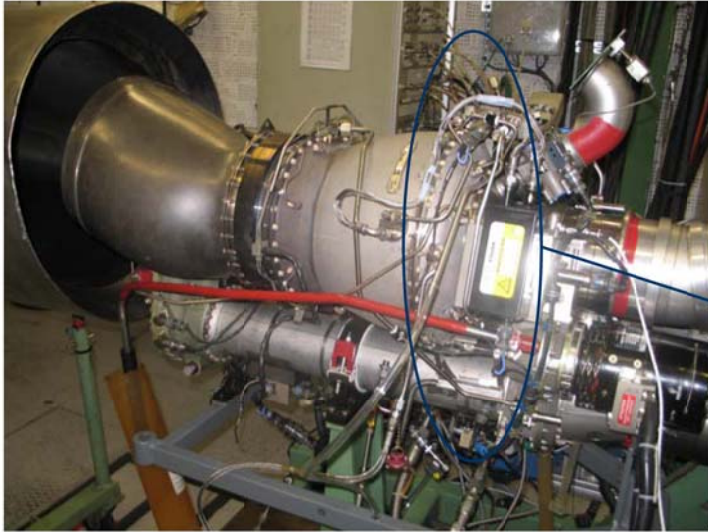
Description of the concerned parts



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Fuel main manifold supply pipe test

Bench installation



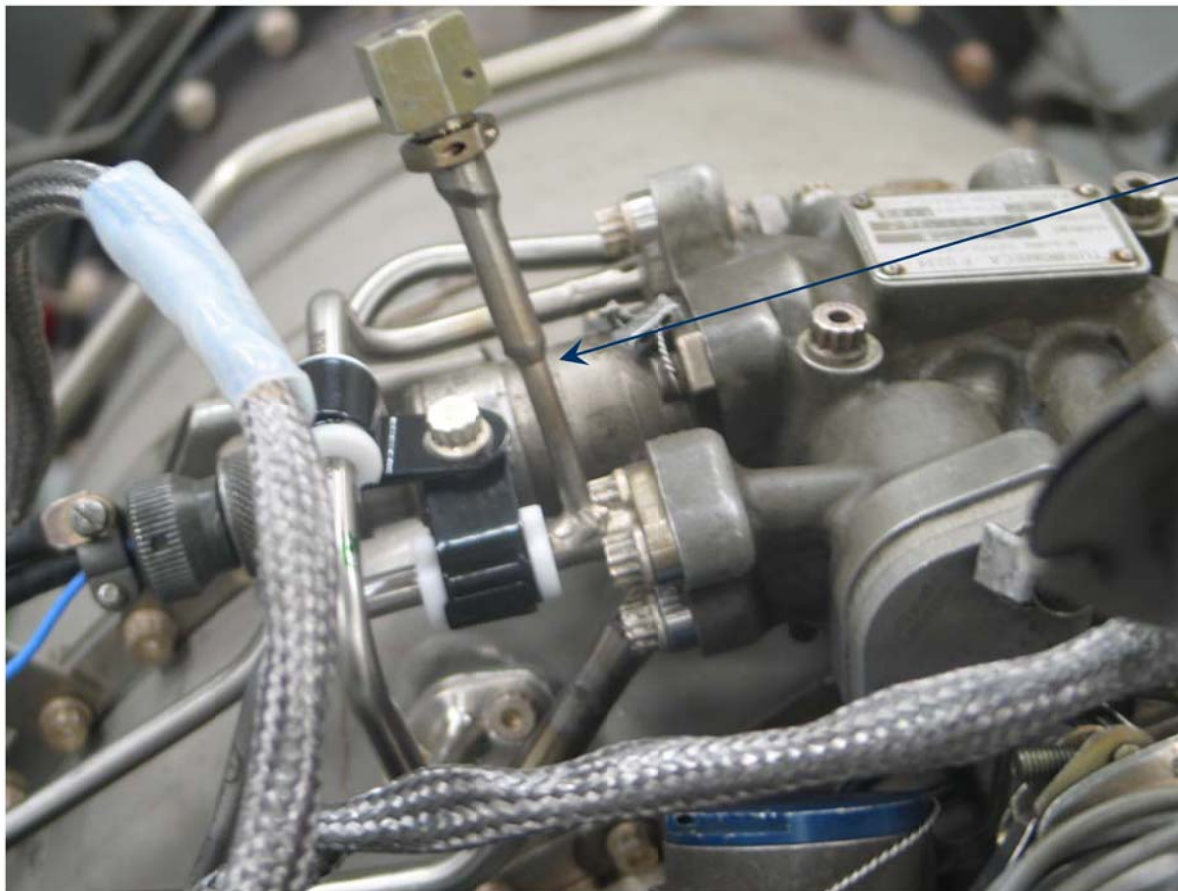
Fuel inlet pressure tapping point

Protection box

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Fuel main manifold supply pipe test

Bench installation



Fuel inlet
pressure
tapping point

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Test #1

test #1

➤ Configuration : representative of an assembly without screws

- ✓ Seals installed with grease (as specified).
- ✓ 1 Screw (located on the upper position) diameter 3mm and length which allowed a free axial displacement of the union up to 9 mm
- ✓ Union positioned in contact with the intermediate casing flange.

➤ Description of the test cycles

- ✓ See next slide

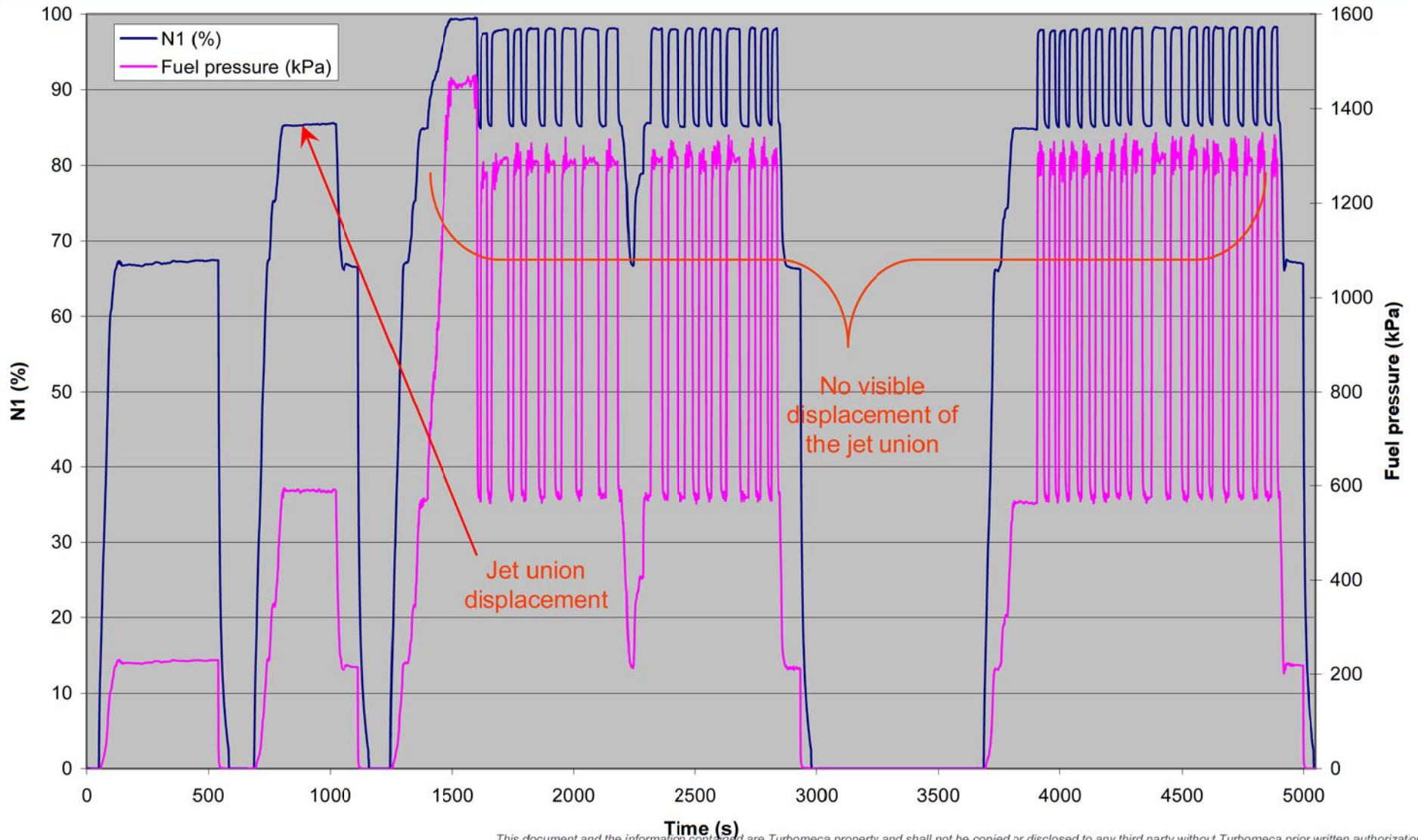
➤ Test findings

- ✓ ~ 39 min of engine operation in 4 phases
- ✓ No fuel leak during the entire phases
- ✓ Displacement of the union during the 2nd phase (~3 mm)



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Test #1



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Test #2

Test #2

➤ Configuration : (what happens if one O-ring is barely in contact)

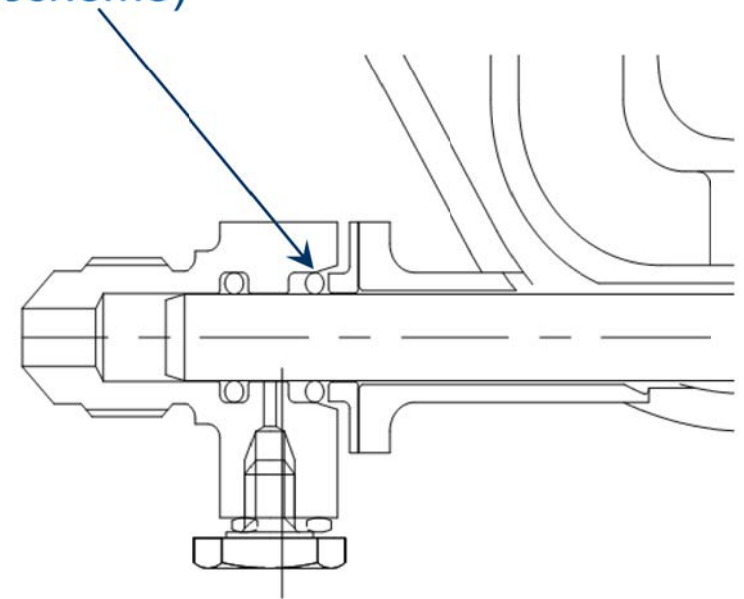
- ✓ Seals installed with grease (as specified)..
- ✓ 1 Screw (located on the upper position) diameter 3mm and length which allowed a free axial displacement of the union up to 9 mm
- ✓ Union positioned with one ring in chamfer. (scheme)

➤ Description of the test cycles

- ✓ See next slide

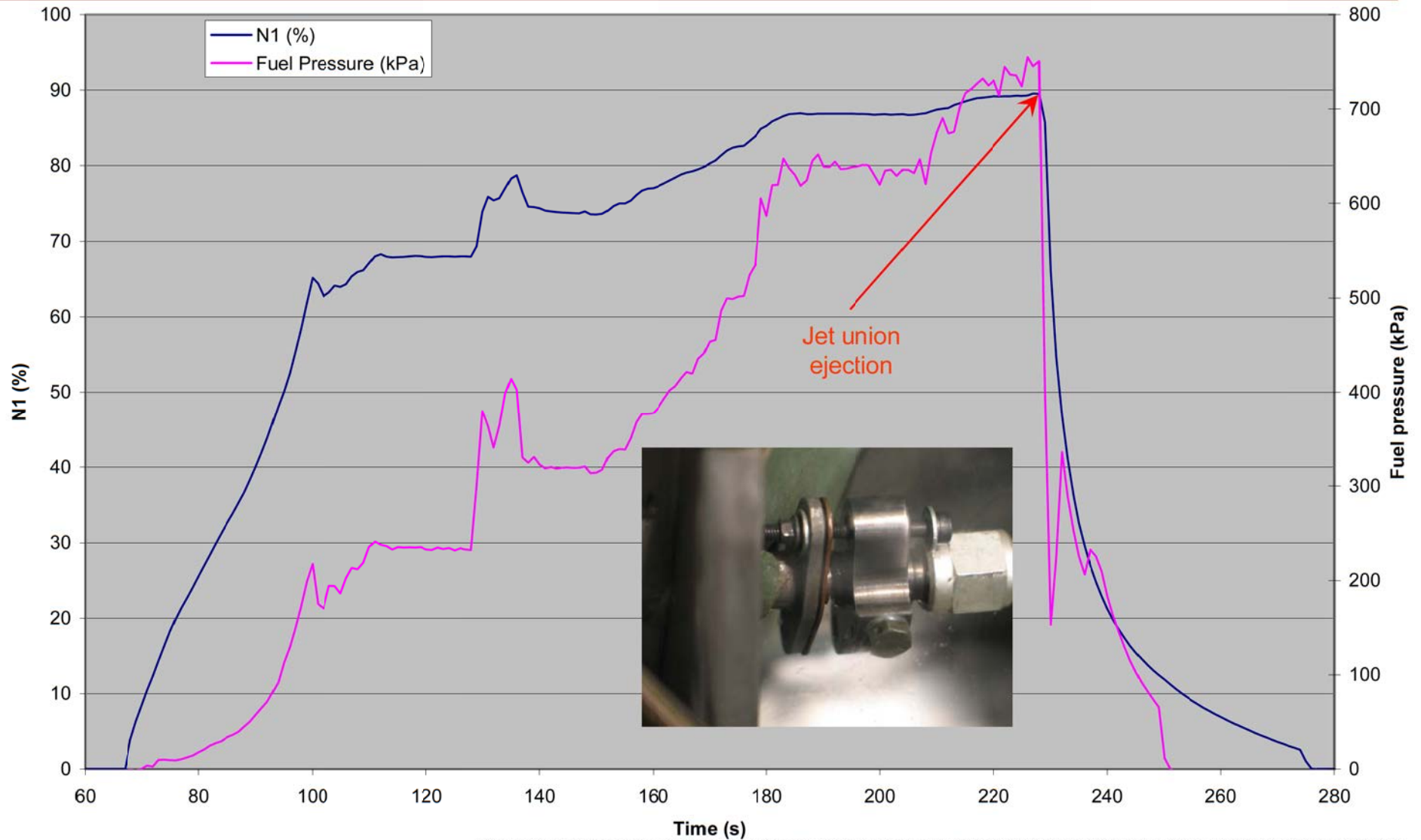
➤ Test findings

- ✓ No fuel leak during the engine start
- ✓ Ejection after 2 min 24 sec of the union and pipe
- ✓ Uncommanded engine shut down without fluctuation



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Test #2



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Test #3

■ Test #3 (engine warm-up in standard conf)

➤ Configuration: (representative of standard configuration but loose nuts)

- ✓ Seals installed with grease (as specified).
- ✓ 2 Screws diameter 4 mm . Hand screwed up to feeling of resistance due to thread lock
- ✓ Union positioned in contact with the intermediate casing flange

➤ Description of the test cycles

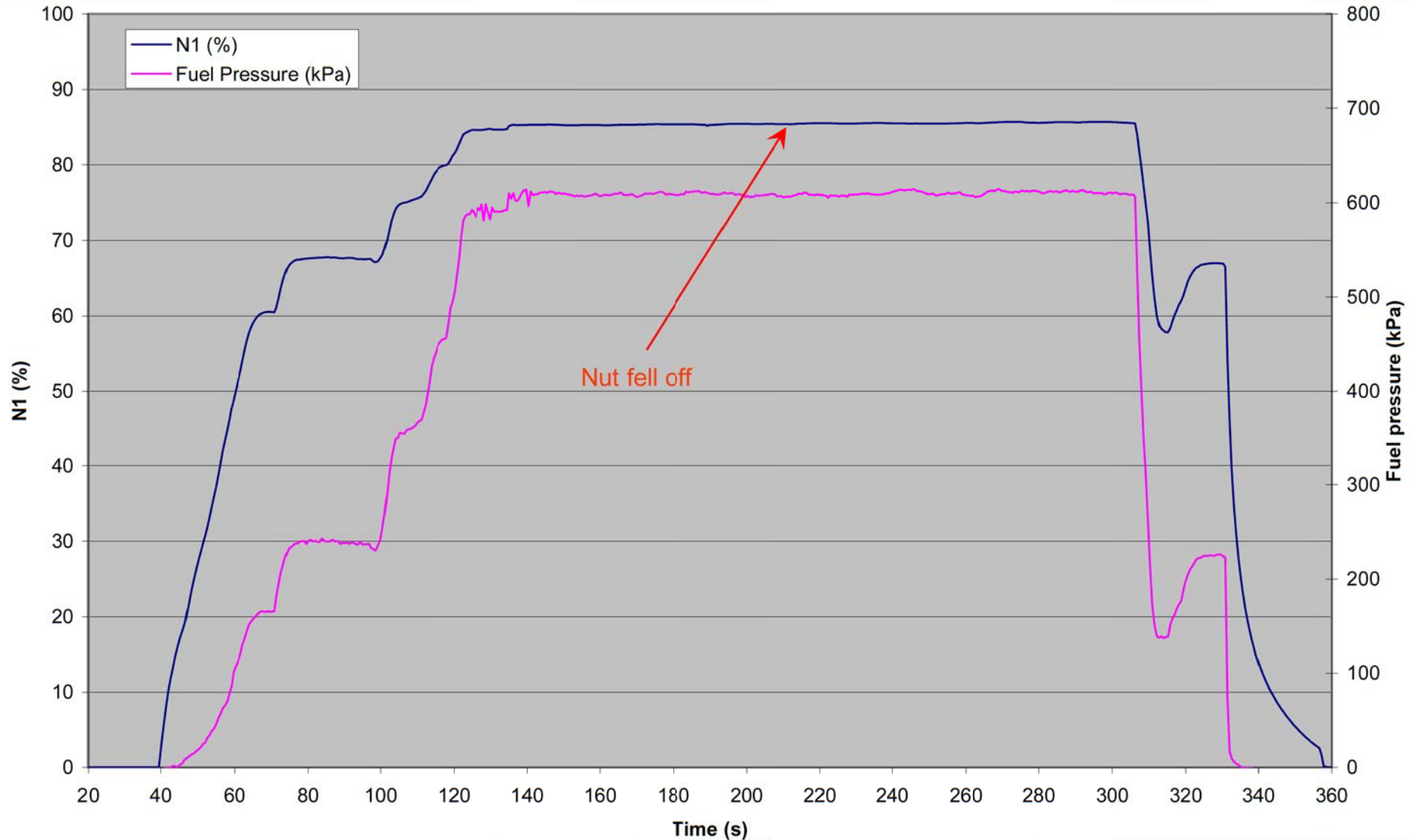
- ✓ See video N°1

➤ Test findings

- ✓ No fuel leak during the engine start
- ✓ Lower nut fell off after 3 min 32 s of operation
- ✓ Upper screw and nut vibrated (erratic movements) but did not fall off
- ✓ Slight displacement of the union
- ✓ No leak

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Test #3



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Test #4

■ Test #4 (resuming of test #3 as is)

➤ Description of the test cycles

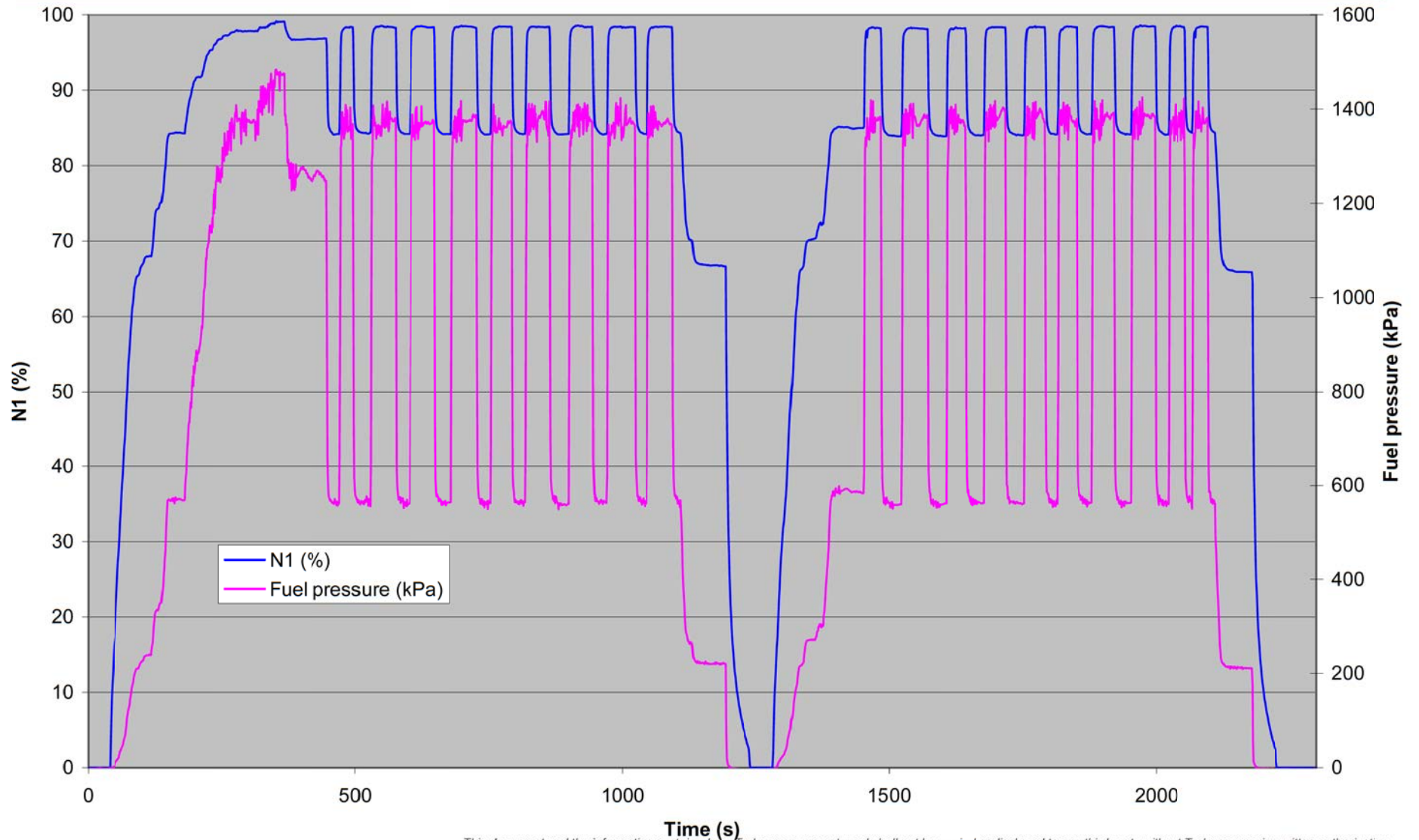
- ✓ See next slide

➤ Test findings

- ✓ ~20 min of engine operation
- ✓ No fuel leak
- ✓ Screw and nut did not fall off during this phase

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Test #4



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Test #5

■ Test #5

➤ Configuration:

- ✓ 1 Screw diameter 4 mm (the serial one) at the upper position. Screwed but not tightened (return to phase 4 configuration)
- ✓ Union positioned near contact with the intermediate casing flange

➤ Description of the test cycles

- ✓ See video N°2

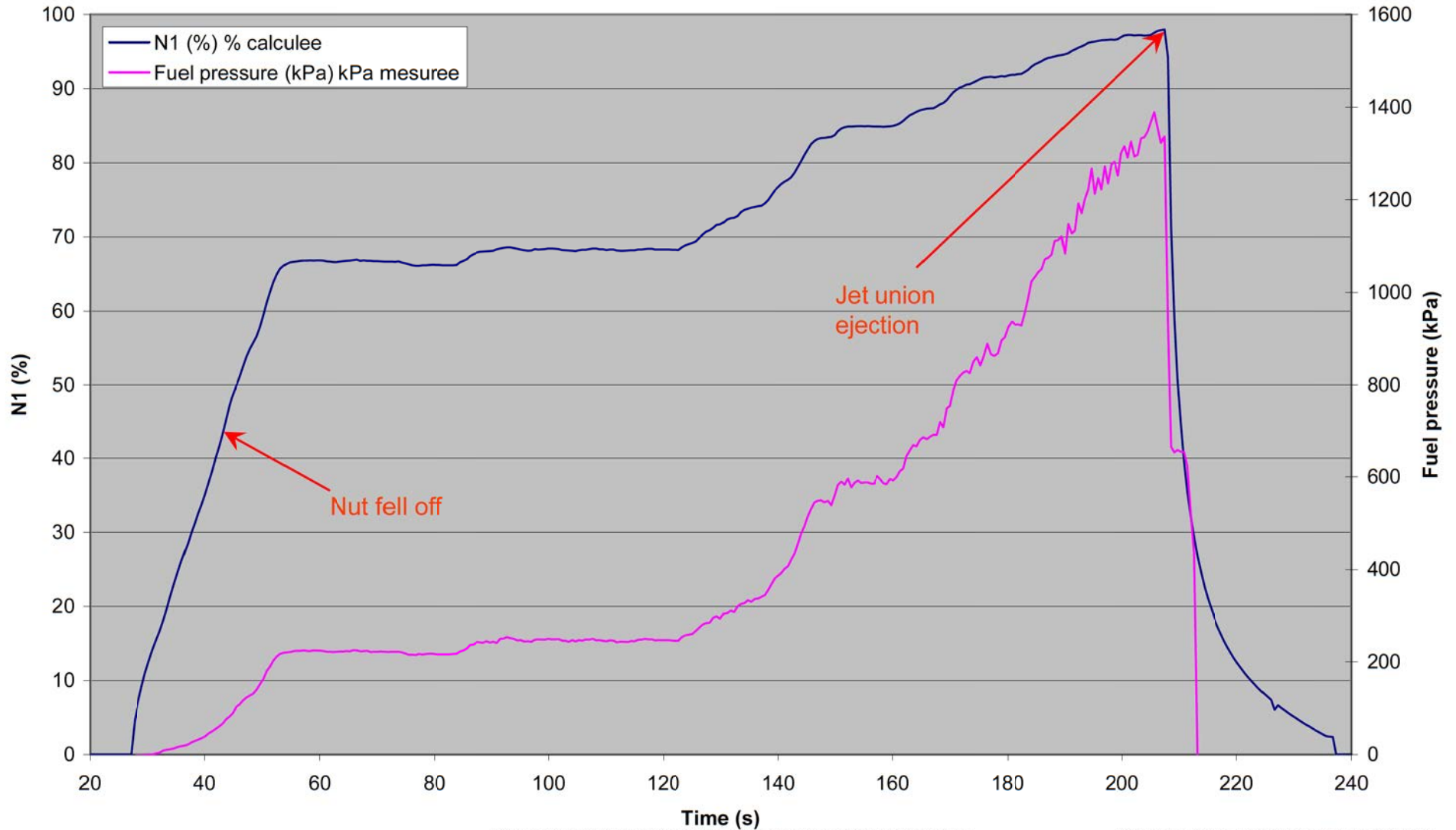
➤ Test findings

- ✓ No fuel leak during the engine start
- ✓ Nut fell off during the starting phase
- ✓ Vibratory behaviour of the screw during the engine acceleration
- ✓ Ejection of the union pipe and screw and uncommanded engine shut down without fluctuation



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Test #5



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Fuel main manifold supply pipe test

■ Conclusions:

- In case of screws and nuts missing, It is possible to run the engine some time without any immediate jet union ejection or fuel leak.
- The vibratory environment tend to “jerk” the jet union and pipe , reduce the seal contact resistance and leads to an ejection of the assembly and an abrupt engine shut down.
- The time of ejection and the level of N1 at which it occurs can change upon the external vibratory input and the assembly adjustment conditions.
- Untightened nut can take several minutes to unscrew upon the vibration behaviour of the engine

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