Bombardier Q300 nose landing gear incidents

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ANZSASI Regional Air Safety Seminar
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September 2010

- Flight WLG – NSN, wx divert to BHE
- No nose gear green on 1st approach
- Go-around, alternate ‘verification’ system = nose gear down
- Alt gear extension C/L not necessary
- FA not informed
- 2x gear warnings on 2nd approach were dismissed


ZK-NEB
airnzealand.co.n
link
R3

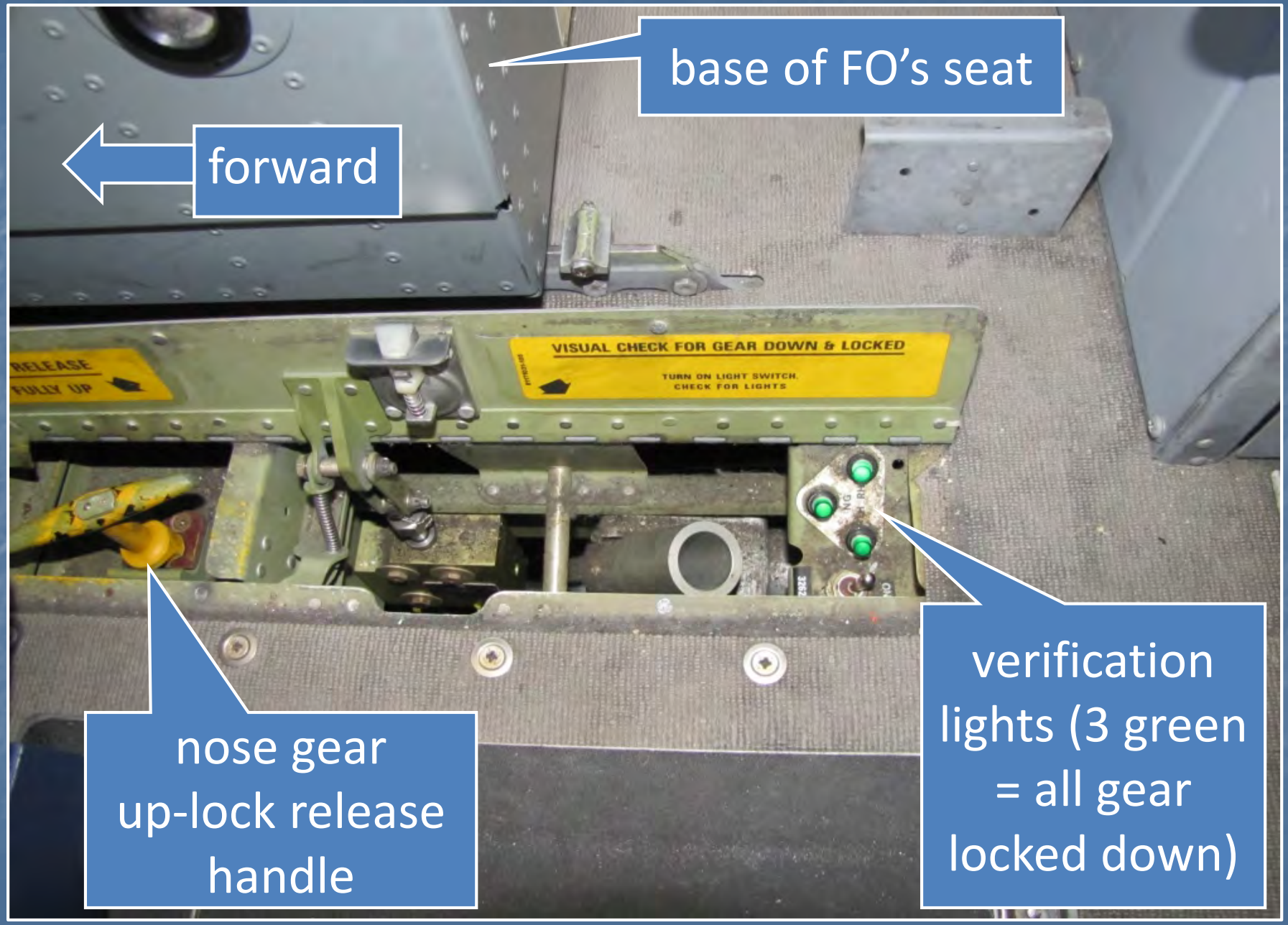
N B W

W -- Wellington

N -- Nelson

B – Blenheim


gear selector lever and advisory indicators


base of FO's seat
forward
VISUAL CHECK FOR GEAR DOWN & LOCKED
TURN ON LIGHT SWITCH.
CHECK FOR LIGHTS
RELEASE
FULLY UP
nose gear up-lock release handle
verification lights (3 green = all gear locked down)

September 2010

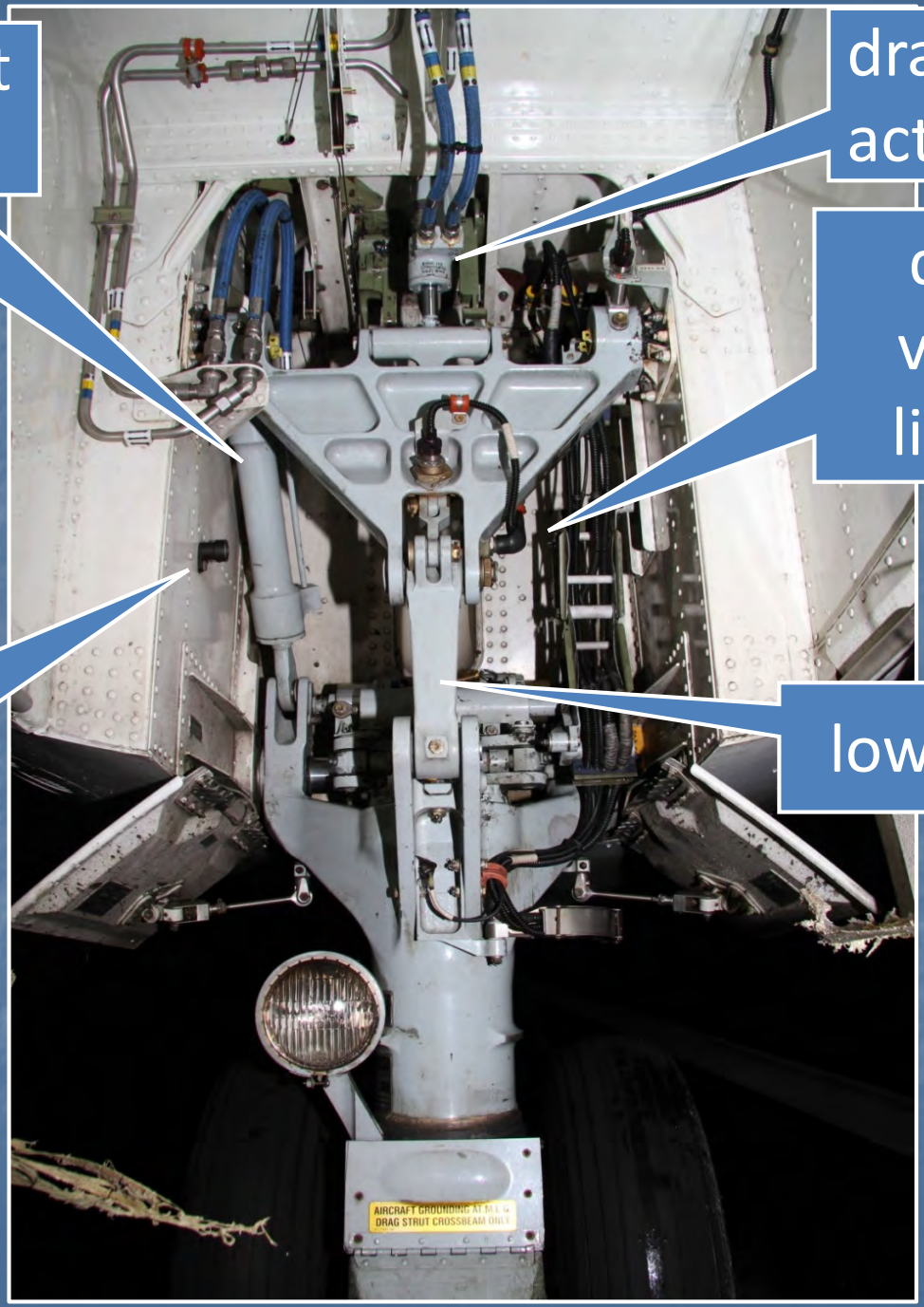
- Bombardier rep attached to operator
- Canadian, US and Australian accredited representatives
- ITAR restrictions invoked by US
- CVR transcript agreed with pilots
- NZDF Defence Technology Agency performed some tests

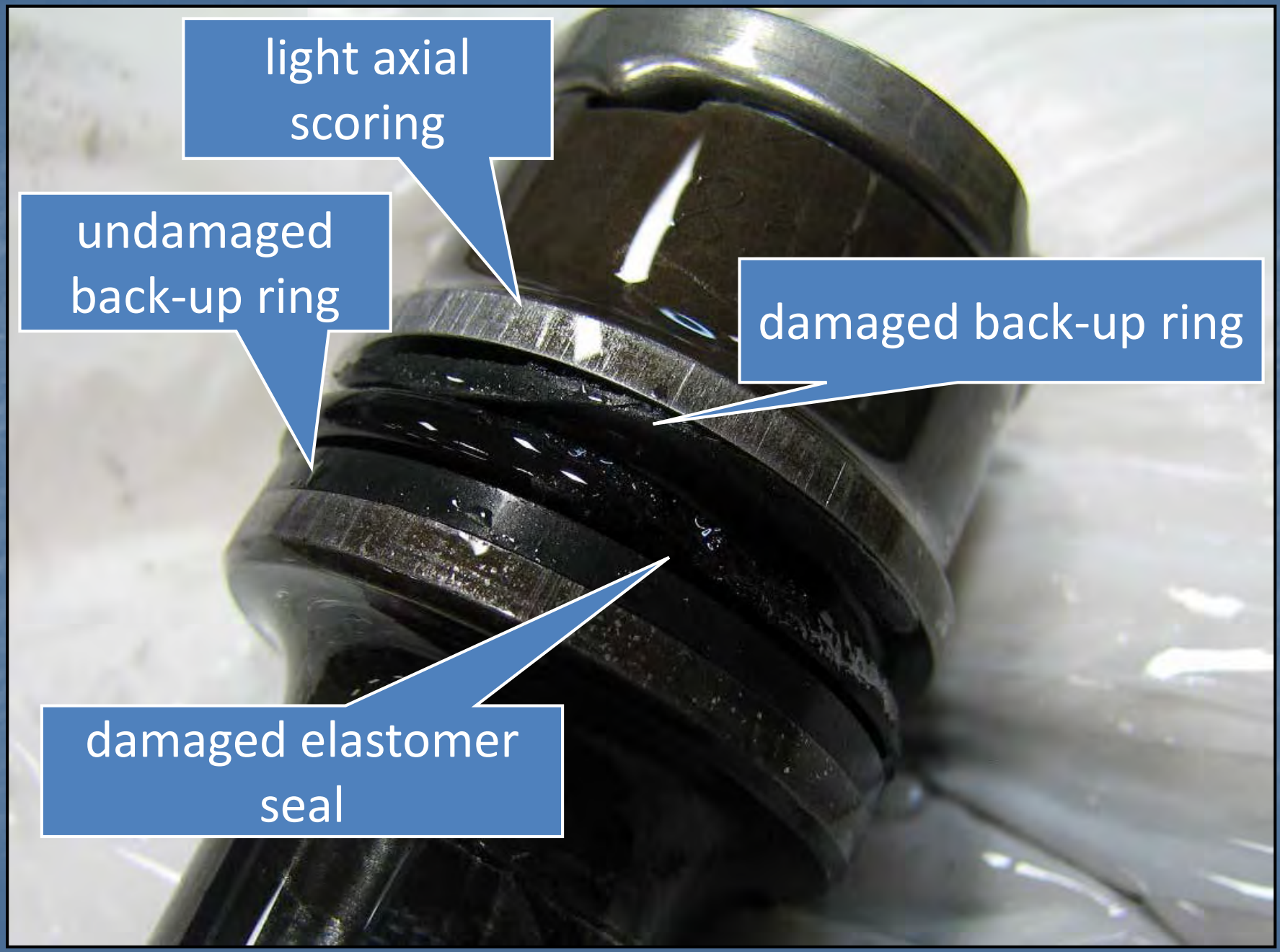
September 2010

- What caused nose gear to not extend?
- Why the erroneous verification?
- Why did pilots dismiss warnings?

September 2010

- What caused nose gear to not extend? Seal debris in actuator ports
- Damage at manufacture or assembly?
- Damage worsened by other debris in fluid, possibly from door actuator
- Alt extension drill unlikely to have succeeded; cycling gear might have
- Previous symptoms not resolved

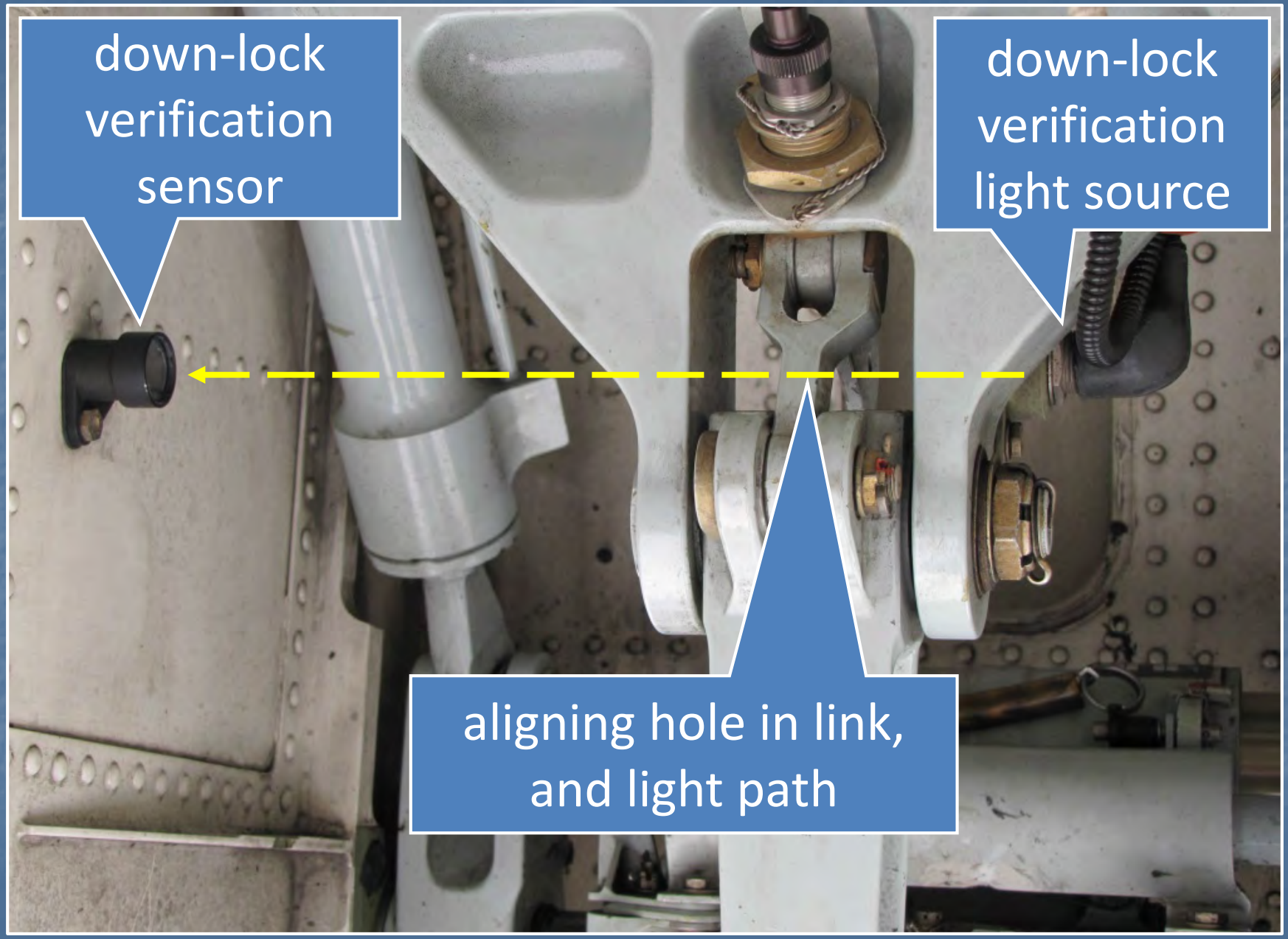

extend/retract actuator
drag strut actuator
down-lock verification light source
down-lock verification sensor
lower drag strut


light axial scoring
undamaged back-up ring
damaged back-up ring
damaged elastomer seal


2011-4504
AIRNELSON LTD
(failed packing)

September 2010

- Why the erroneous verification?
  Verification system was deficient
- Taxi light had to be off during check of verification system
- Sensors prone to water ingress


down-lock verification sensor
down-lock verification light source
aligning hole in link, and light path

September 2010

- Why did pilots dismiss warnings?
  Misled by erroneous verification, QRH text and rationalisation of defect

- CRM not fully utilised because FA was not informed of situation and ATC was not asked to report gear position

Safety actions - Manufacturer

- SLs dealing with alternate gear extensions and situations beyond scope of QRH (overlap with Feb 2011 incident)
- Check alt verification with taxi light off
- Cycling not recommended, unless alt extension procedure unsuccessful
- Special Inspection of alt indication system
- Re-design of alt verification system

Safety actions - Operator

- Incorporated Bombardier's changes
- SOP change to require 'third party' check of conflicting gear indications
- Installed better filters on hydraulic ground test rig

Safety recommendation

- To Director of Civil Aviation to urge Transport Canada to:
  - Note the instances of false verification of gear position and potential for false indication to cause an accident , and
  - Require Bombardier to improve the reliability and dependability of the verification system.

Key lessons - September 2010

- Intermittent defects likely to be pre-cursors of failure. Diagnosis of defects should be exhaustive
- Alerts and warnings should not be dismissed without full consideration of all information
- System knowledge beyond that assumed for QRH use is desirable

Investigation difficulties, Sep 2010

- Operator works at faster pace
- Initially, own system knowledge
- Control of many NLG actuators pulled for inspection
- Dealing with various parties' interests; and ITAR
- Care needed in report terminology

February 2011

- Flight HLZ-WLG
- No nose wheel steering on departure
- Proceeded as per QRH and MEL
- No gear extended on approach WLG
- Alt extension C/L; still no nose gear
- Divert to BHE
- Planned partial gear landing

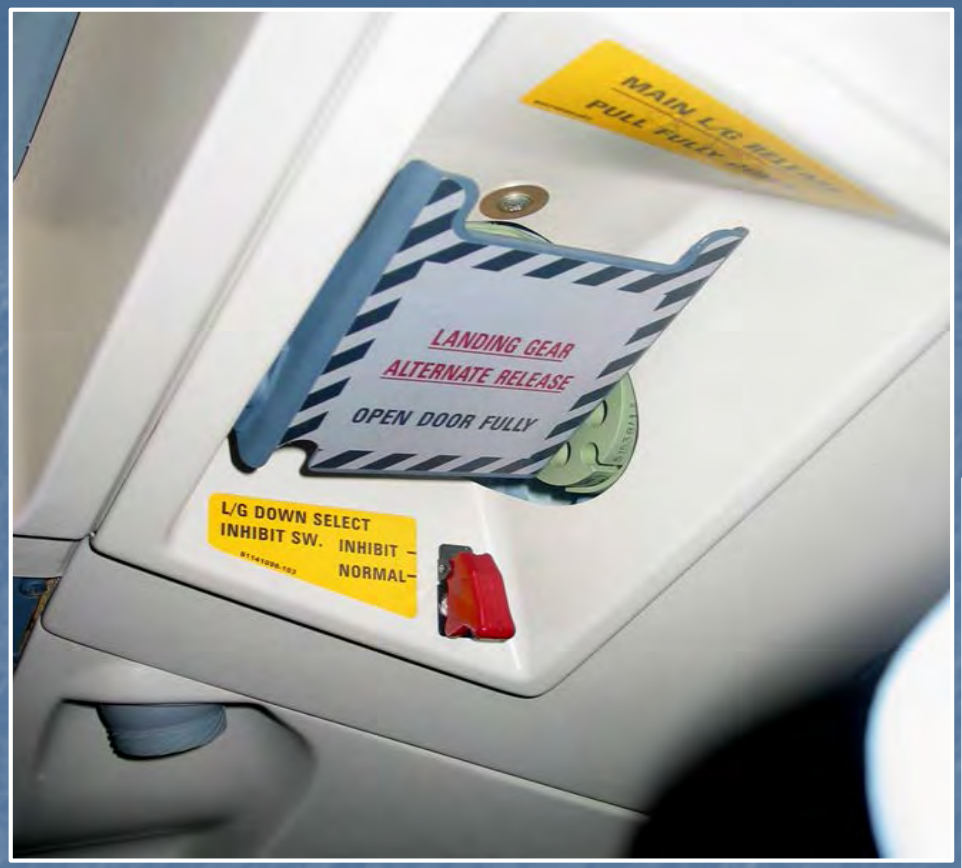
H

B W

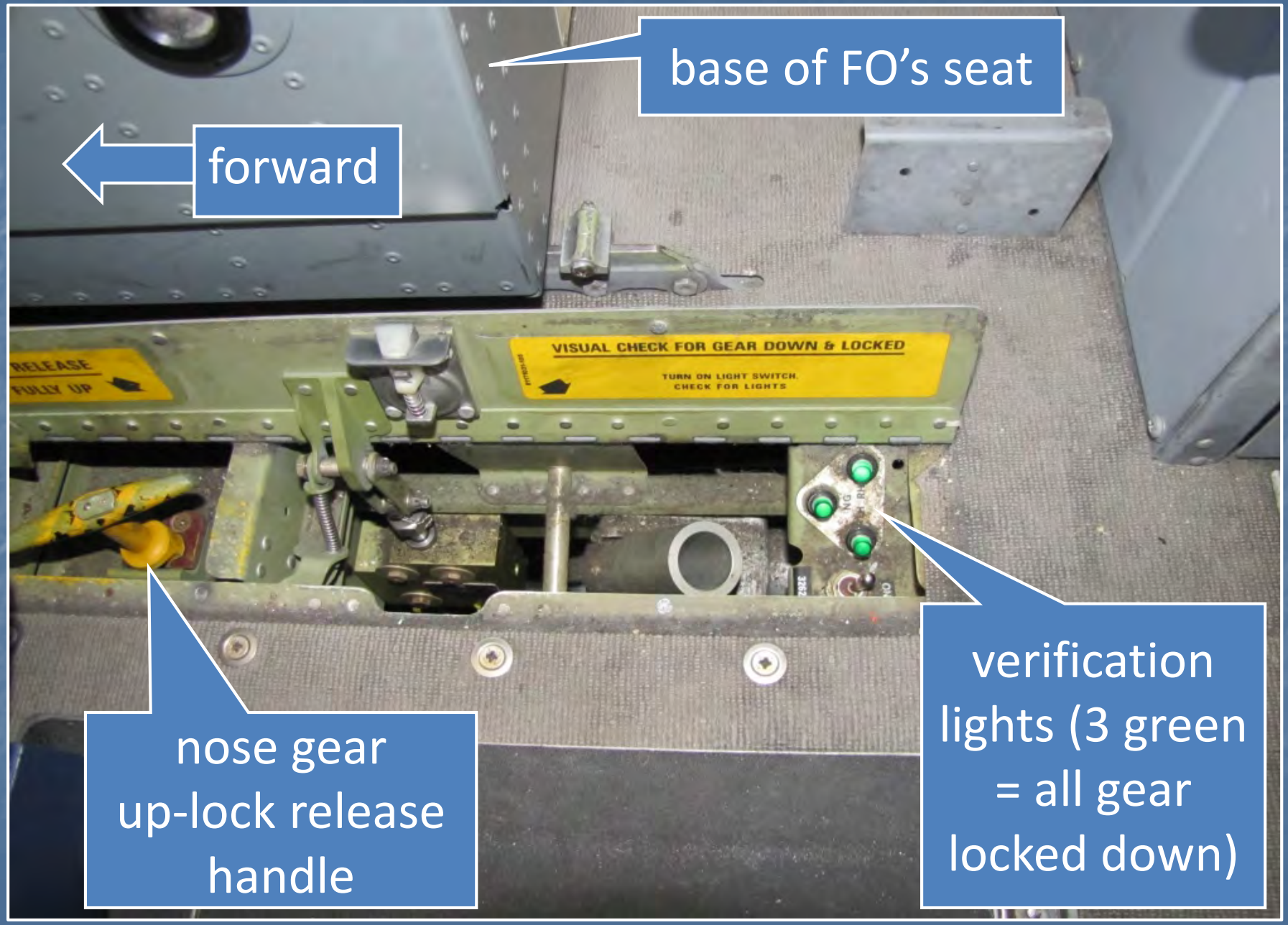
H -- Hamilton

W -- Wellington

B – Blenheim


MAIN L/G RELEASE
PULL FULLY
LANDING GEAR
ALTERNATE RELEASE
OPEN DOOR FULLY
L/G DOWN SELECT
INHIBIT SW. INHIBIT –
NORMAL–


MAIN L/G RELEASE
PULL FULLY
CAUTION
ENSURE ALL WHEEL WELLS
ARE CLEAR OF OBSTRUCTIONS
BEFORE CLOSING ACCESS PANEL
TO CLOSE DUMP VALVE.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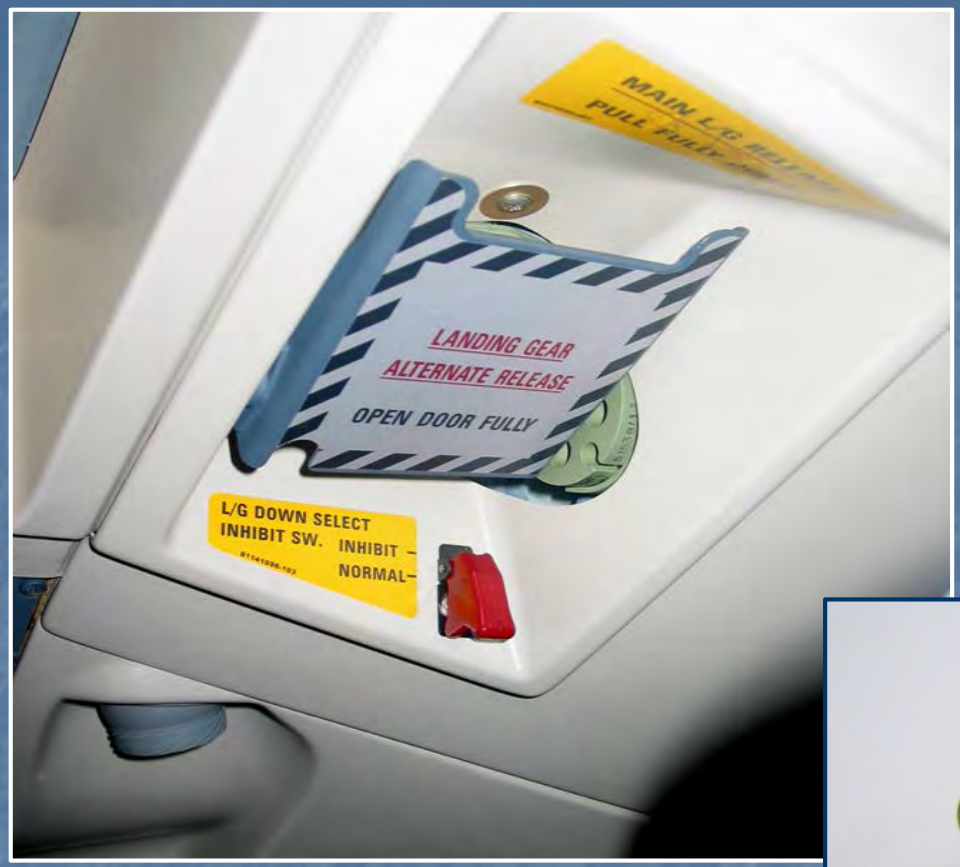
February 2011

- What caused normal gear extension to fail at Wellington?
- Why didn’t NLG extend with alternate system?

February 2011

- What caused normal gear extension to fail at Wellington? Faulty ‘landing gear down select inhibit switch’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PULL FULLY
LANDING GEAR
ALTERNATE RELEASE
OPEN DOOR FULLY
L/G DOWN SELECT
INHIBIT SW.
INHIBIT –
NORMAL–

February 2011

- This was also cause of nose wheel steering defect at HLZ. Both systems get hydraulic pressure when the gear is selected DOWN
- MEL for NWS didn’t consider role of landing gear supply pressure

February 2011

- Why didn't NLG extend under alt system? There was no defect with alt system - FO didn't pull hard enough or hold tension for long enough
- Bombardier noted high forces in its AFM and SLs, but not in its QRH. Air Nelson training and custom QRH did not include that information.

February 2011

- Simulator was not representative of force required to release uplock
- Actual force (fleet check) ~ 30+ kg
- Pilots use uplock release handle to open doors for pre-flight ~ 6-8 kg
- Simulator forces ~ 6.5 kg for doors and 8.1 kg for uplock

February 2011

Other issues identified:

- Operator trouble-shooting via ATC
- Adherence to QRH: ‘Brace!’ command was given too early
- Format and clarity of QRH checklists

LANDING GEAR FAILS TO EXTEND

Is the Landing Gear Inop Caution Light illuminated?

LDG GEAR INOP

YES

- Refer to Landing Gear Inop ..... Below

NO

- Landing Gear Inhibit Switch ..... NORM
- Landing Gear Alternate Release door ..... Closed
- Landing Gear Alternate Extension door ..... Closed

Landing Gear extends/indicates normally?

YES

— — — END — — —

NO

- Landing Gear Alternate Extension door ..... Open
- Landing Gear Down Verification Light Switch ..... On/Check/Off

Confirm gear is down and locked. If either the "Landing gear down and locked advisory light" or the "Landing gear down verification light" is on, the gear is down and locked.

Is at least one green light illuminated for each Gear Leg position?

YES

Landing Gear is down and safe.

- Landing Gear Alternate Extension door..... Close

— — — END — — —

NO

- Carry out an Alternate Gear Extension.. Page 14.4

LANDING GEAR INOP

LDG GEAR INOP

- Carry out an Alternate Gear Extension .... Page 14.4

Safety actions - Manufacturer

- Amended MEL for NWS, to require confirmation of hyd pressure
- Issued SL giving more technical info on landing gear, alternate extension, and further non-normal options
- Repeated some information from Sep 2010 incident

Safety actions - Operator

- Revised landing gear system training
- Revised QRH format and content
- Modified simulator NLG uplock release force
- Revised alt gear extension method – pause after doors unlocked.

Safety actions - Regulator

- Amended operator certification process to evaluate flight procedures for large aircraft against Rule criteria, and confirmation that any customised procedures included all pertinent information provided by the manufacturer.

Safety recommendation

- To Director of Civil Aviation:
  - to liaise with Transport Canada to make other NAAs aware of incident and ... Dash 8 flight simulators to closely representing actual forces in alternate gear extension
  - to urge operators to adopt QRH formats that reduce possibility of misreading or omitting a step.

Key lessons - February 2011

- Flight simulator procedures should be as robust and rigorous as is required on the aircraft
- Pilots should know of any simulator characteristics that are different from those of the aircraft
- QRH design should minimise potential for error as used in times of high workload and high stress.

Investigation difficulties, Feb 2011

- Investigation overlapped with that of Sep 2010 incident
- Can't be present at all stages of operator's troubleshooting
- Interpreting CVRs; remember non-verbal comms are a big part of crew communication and coordination

The End