ANSV AGENZIA NAZIONALE PER LA SICUREZZA DEL VOLO

DICHIARAZIONE INTERMEDIA

INCIDENTE
occorso all'aeromobile
Fokker F27 MK050 marche SE-LEZ,
aeroporto di Catania Fontanarossa,
30 aprile 2016

OBIETTIVO DELL'INCHIESTA DI SICUREZZA

L'Agenzia nazionale per la sicurezza del volo (ANSV), istituita con il decreto legislativo 25 febbraio 1999 n. 66, si identifica con l'autorità investigativa per la sicurezza dell'aviazione civile dello Stato italiano, di cui all'art. 4 del regolamento UE n. 996/2010 del Parlamento europeo e del Consiglio del 20 ottobre 2010. **Essa conduce, in modo indipendente, le inchieste di sicurezza**.

Ogni incidente e ogni inconveniente grave occorso ad un aeromobile dell'aviazione civile è sottoposto ad inchiesta di sicurezza, nei limiti previsti dal combinato disposto di cui ai paragrafi 1 e 4 dell'art. 5 del regolamento UE n. 996/2010.

Per inchiesta di sicurezza si intende un insieme di operazioni comprendente la raccolta e l'analisi dei dati, l'elaborazione delle conclusioni, la determinazione della causa e/o di fattori concorrenti e, ove opportuno, la formulazione di raccomandazioni di sicurezza.
L'unico obiettivo dell'inchiesta di sicurezza consiste nel prevenire futuri incidenti e inconvenienti, non nell'attribuire colpe o responsabilità (art. 1, paragrafo 1, regolamento UE n. 996/2010). Essa, conseguentemente, è condotta indipendentemente e separatamente da inchieste (come ad esempio quella dell'autorità giudiziaria) finalizzate all'accertamento di colpe o responsabilità.
L'inchiesta di sicurezza è condotta in conformità con quanto previsto dall'Allegato 13 alla Convenzione relativa all'aviazione civile internazionale (stipulata a Chicago il 7 dicembre 1944, approvata e resa esecutiva in Italia con il decreto legislativo 6 marzo 1948, n. 616, ratificato con la legge 17 aprile 1956, n. 561) e dal regolamento UE n. 996/2010.

Ogni inchiesta di sicurezza si conclude con una relazione redatta in forma appropriata al tipo e alla gravità dell'incidente o dell'inconveniente grave. Essa può contenere, ove opportuno, raccomandazioni di sicurezza, che consistono in una proposta formulata a fini di prevenzione.
Una raccomandazione di sicurezza non costituisce, di per sé, una presunzione di colpa o un'attribuzione di responsabilità per un incidente, un inconveniente grave o un inconveniente (art. 17, paragrafo 3, regolamento UE n. 996/2010).
La relazione garantisce l'anonimato di coloro che siano stati coinvolti nell'incidente o nell'inconveniente grave (art. 16, paragrafo 2, regolamento UE n. 996/2010).

La presente **dichiarazione intermedia** è stata redatta in linea con quanto previsto dalla previsione 6.6. dall'Allegato 13 alla Convenzione relativa all'aviazione civile internazionale, nonché dall'art. 16, paragrafo 7, del regolamento UE n. 996/2010: il suo scopo consiste, in particolare, nel rendere noti, **unicamente a fini di prevenzione**, le informazioni sulle osservazioni dei fatti, i progressi dell'inchiesta di sicurezza e le eventuali questioni di sicurezza interessate, nel limite in cui tali informazioni non compromettano, però, gli obiettivi della stessa inchiesta di sicurezza e la sua regolare conclusione.

Alcuni degli aspetti trattati nella presente dichiarazione intermedia potranno essere eventualmente oggetto di ulteriori approfondimenti e precisazioni; **alcune informazioni potranno, altresì, essere soggette a modifica o correzione, nel caso in cui durante l'inchiesta si rendano disponibili ulteriori conoscenze**.

La presente dichiarazione intermedia non contiene le analisi delle evidenze acquisite, le conclusioni e le cause dell'incidente, che faranno parte della relazione finale d'inchiesta.

Nessuna informazione contenuta nella presente dichiarazione intermedia può essere arbitrariamente interpretata come una indicazione sulle conclusioni alle quali arriverà l'inchiesta di sicurezza.

L'utilizzazione di questa dichiarazione intermedia per finalità diverse da quelle perseguite dall'inchiesta di sicurezza potrebbe portare ad improprie ed erronee interpretazioni.

GLOSSARIO

(A): Aeroplane.
AAIB (UK): Air Accident Investigation Branch (UK), Autorità investigativa del Regno Unito per la sicurezza dell'aviazione civile.
AMM: Aircraft Maintenance Manual.
ANSV: Agenzia nazionale per la sicurezza del volo.
ATPL: Airline Transport Pilot Licence, licenza di pilota di linea.
CND: controlli non distruttivi.
COCKPIT: cabina di pilotaggio.
COD. NAV.: codice della navigazione.
CVR: Cockpit Voice Recorder, registratore delle comunicazioni, delle voci e dei rumori in cabina di pilotaggio.
ENAC: Ente nazionale per l'aviazione civile.
FDR: Flight Data Recorder, registratore dei dati di volo.
FMS: Flight Management System.
ICAO/OACI: International Civil Aviation Organization, Organizzazione dell'aviazione civile internazionale.
MTOM: Maximum Take Off Mass, massa massima al decollo.
S/N: Serial Number.
START: Simple Triage & Rapid Treatment.
UTC: Universal Time Coordinated, orario universale coordinato.

Tutti gli orari riportati nella presente relazione d'inchiesta, se non diversamente specificato, sono espressi in **ora UTC**, che, alla data dell'evento, corrispondeva all'ora locale meno due ore.

DICHIARAZIONE INTERMEDIA
RELATIVA ALL'INCIDENTE
OCCORSO ALL'AEROMOBILE FOKKER F27 MK050 MARCHE SE-LEZ

(art. 16, paragrafo 7, reg. UE n. 996/2010; previsione 6.6 Allegato 13 ICAO)

Tipo dell'aeromobile e marche	Velivolo Fokker F27 MK050 marche SE-LEZ.
Data e ora	30 aprile 2016, 09.35' UTC.
Luogo dell'evento	Aeroporto di Catania Fontanarossa (LICT).
Descrizione dell'evento	L'aeromobile, proveniente da Rimini con a bordo 18 passeggeri e 3 membri di equipaggio, dopo aver effettuato un mancato avvicinamento a causa della segnalazione in cabina di pilotaggio di carrello anteriore non esteso, atterrava all'aeroporto di Catania Fontanarossa sul solo carrello principale. L'atterraggio avveniva inizialmente sul carrello principale e, successivamente, sulla parte anteriore della fusoliera. L'aeromobile arrestava la corsa di atterraggio rimanendo in pista. Le operazioni di evacuazione dei passeggeri e dell'equipaggio avvenivano regolarmente. Il giorno precedente erano stati eseguiti alcuni interventi manutentivi sull'aeromobile, incluso uno riguardante il carrello anteriore. L'incidente in esame si verificava in occasione del secondo volo dopo la effettuazione della citata manutenzione.
Esercente dell'aeromobile	Air Vallée SpA.
Natura del volo	Operazioni commerciali.
Persone a bordo	21 (equipaggio 3, passeggeri 18).
Danni all'aeromobile	L'aeromobile presentava danni da strisciamento con l'asfalto della pista nella parte inferiore della fusoliera, posteriormente al vano carrello anteriore (foto 2 in allegato "A"). Il rivestimento della fusoliera anteriore presentava alcune piegature nella parte superiore della stessa, nel tratto fra il *cockpit* e l'attacco delle semiali, per probabile deformazione plastica della struttura causata dalla flessione della stessa verso l'alto. I portelli del vano carrello risultavano entrambi danneggiati in prossimità dei loro bordi interni. All'interno del vano carrello anteriore era presente una interferenza fra i due pneumatici del carrello ed il pannello anteriore verticale del vano carrello, parzialmente deformato dall'interferenza realizzata con le ruote. Ulteriori danni, esternamente non visibili, potrebbero emergere in sede di eventuale riparazione dell'aeromobile.
Altri danni	Le 21 persone a bordo venivano inizialmente visitate dal personale medico in servizio presso l'aeroporto di Catania

Fontanarossa non appena abbandonato l'aeromobile, quando si trovavano ancora nei pressi dello stesso in una zona dichiarata sicura dai Vigili del fuoco. Applicando il protocollo START, veniva assegnato codice verde a tutti.
Una seconda valutazione medica era poi eseguita all'interno della struttura aeroportuale. Delle 21 persone, una si allontanava senza dare alcuna comunicazione ai sanitari e senza sottoporsi a visita medica, 14 persone venivano valutate con codice verde e potevano lasciare l'aeroporto, mentre a 4 persone veniva assegnato codice giallo con patologie di vario tipo (di queste 4 persone, 2 rifiutavano l'ospedalizzazione, mentre le altre 2 erano inviate per accertamenti in ospedale).

Informazioni relative al personale di volo e al personale preposto alla manutenzione

Comandante.
Maschio, età 44 anni, nazionalità italiana. Titolare di ATPL (A) in corso di validità. Il comandante, alla data dell'evento, era in possesso delle abilitazioni previste per effettuare il volo ed aveva maturato un'esperienza di volo di 6850 ore totali, di cui poco meno di 800 effettuate sul tipo di aeromobile F27 MK050.

Primo ufficiale.
Femmina, età 32 anni, nazionalità italiana. Titolare di ATPL (A) in corso di validità. Il primo ufficiale, alla data dell'evento, era in possesso delle abilitazioni previste per effettuare il volo ed aveva maturato un'esperienza di volo di 2680 ore totali.

Di seguito si forniscono informazioni relative ai tre tecnici che, il 29 aprile 2016, avevano eseguito, in Italia, gli interventi manutentivi riportati al punto successivo.

Tecnico 1.
Maschio, età 51 anni, nazionalità svedese**.** In possesso di licenza di manutenzione aeronautica Part-66 rilasciata dalla Swedish Transport Agency, in corso di validità. Part-66 *type rating* categoria B1/B2 su aeromobili tipo Fokker 50/60.

Tecnico 2.
Maschio, età 30 anni, nazionalità italiana**.** In possesso di licenza di manutenzione aeronautica Part-66 rilasciata dall'ENAC, in corso di validità. Part-66 *type rating* categoria A su aeromobili tipo Fokker F27 e Fokker F50.

Tecnico 3.
Maschio, età 46 anni, nazionalità italiana. In possesso di licenza di manutenzione aeronautica Part-66 rilasciata dall'ENAC, in corso di validità. Part-66 *type rating* categoria B1 e C su aeromobili tipo Fokker F27 e Fokker F50.

Informazioni relative all'aeromobile ed al propulsore

L'aeromobile in questione, appartenente alla categoria "*large aeroplane*", è stato prodotto, con il S/N 20128, dalla olandese Fokker VFM B.V. È dotato di ala alta ed è equipaggiato con due motori turboelica Pratt & Whitney PW-125B da 2500 shp, associati ad eliche esapala. Ha una MTOM di 20.820 kg.
Il carrello è del tipo triciclo retrattile, costruito dalla Messier-Bugatti-Dowty (oggi Safran Landing Systems). In particolare, il carrello anteriore è a doppio asse ed è dotato di un ammortizzatore oleo-pneumatico; lo stesso è orientabile tramite un meccanismo di *rack and pinion type*.
La documentazione tecnico-amministrativa (certificato di immatricolazione, certificato di navigabilità, certificato acustico e licenza di stazione radio) dell'aeromobile marche SE-LEZ è stata rilasciata dalla Swedish Civil Aviation Authority (oggi Swedish Transport Agency).
L'aeromobile, di proprietà di una società svedese, era, al momento dell'incidente, in esercenza ad un operatore italiano. La sorveglianza (*technical and operational survey*) sul suddetto aeromobile era stata delegata, da parte della citata Swedish Transport Agency (autorità di riferimento in quanto lo stesso era immatricolato in Svezia), all'ENAC.
Il certificato di navigabilità era stato rinnovato in Italia il 29 giugno 2015, con scadenza 23 luglio 2016: era quindi in regolare corso di validità al momento dell'incidente.
Il giorno 29 aprile 2016, in Italia, presso una società certificata dall'ENAC, il velivolo in questione era stato sottoposto ai seguenti interventi manutentivi:

- sostituzione guarnizioni interne all'ammortizzatore carrello anteriore per perdita idraulica;
- aggiornamento dati FMS;
- test funzionale dei modi C e S del transponder;
- controllo presenza grasso radice pale eliche;
- CND (*eddy current*) sulle *inboard* e *outboard torsion beam* sta.4052.

Informazioni sul luogo dell'evento

L'aeroporto di Catania Fontanarossa (LICC) è un aeroporto aperto al traffico aereo internazionale, operativo H24. È dotato di una sola pista di volo, in asfalto, avente le seguenti caratteristiche: designazione 08-26, QFU 082°-262°, lunghezza 2436 m, larghezza 45 m. Servizio antincendio aeroportuale CAT 8 ICAO.

Informazioni meteorologiche

Al momento dell'incidente le condizioni meteorologiche sull'aeroporto di Catania Fontanarossa non presentavano elementi di criticità correlabili con la dinamica dell'evento.

Stato di progressione inchiesta

Il giorno successivo a quello dell'evento veniva effettuato il sopralluogo operativo da parte del personale ANSV. Da una prima ispezione visiva risultavano evidenti segni di interferenza fra i due pneumatici del carrello anteriore e la paratia del vano

carrello (foto 3 in allegato "A"), interferenza verificatasi, verosimilmente, in fase di retrazione del carrello dopo il decollo dall'aeroporto di Rimini. L'interferenza degli penumatici bloccati dalla paratia è riconducibile alla posizione di iperestensione in cui veniva rinvenuta la gamba di forza del carrello. Nei giorni successivi si provvedeva a smontare il carrello per eseguire un esame approfondito, che veniva condotto nel mese di giugno 2016, nel Regno Unito, presso i laboratori del costruttore del componente in questione (Safran Landing Systems). Tali esami, direttamente commissionati dall'ANSV, sono stati condotti sotto il diretto controllo, in loco, degli investigatori della stessa ANSV, nonché di un investigatore dell'omologa autorità investigativa del Regno Unito (AAIB UK), che aveva titolo a partecipare agli accertamenti in questione alla luce di quanto previsto dalla normativa vigente in materia di inchieste di sicurezza.

Lo smontaggio del carrello anteriore avveniva sgonfiando i due pneumatici e, al fine di preservare evidenze utili per un esame approfondito, senza alterare lo stato del carrello anteriore.

Nel corso dell'inchiesta di sicurezza sono state acquisite dichiarazioni testimoniali utili alla comprensione della dinamica dell'evento e sono stati scaricati i dati contenuti nei registratori di volo (FDR/CVR). Le informazioni tratte dal CVR confermano quanto dichiarato dai piloti in ordine alla gestione dell'emergenza. Per quanto concerne i dati registrati dal FDR, gli stessi non forniscono indicazioni utili o aggiuntive riguardo al malfunzionamento del carrello anteriore.

Dalle evidenze acquisite allo stato attuale risulta quanto segue. L'aeromobile era in corrente stato di navigabilità. L'equipaggio di volo era in possesso delle licenze e delle abilitazioni previste per l'effettuazione del volo. L'operatore italiano esercente dell'aeromobile marche SE-LEZ era in possesso della licenza di esercizio e delle certificazioni previste dalla normativa vigente. La sorveglianza sull'aeromobile, di immatricolazione svedese, era stata delegata, come consentito, dalla competente autorità svedese (Swedish Transport Agency) all'autorità dell'aviazione civile dello Stato dell'operatore (ENAC). Le condizioni meteorologiche non presentavano elementi di criticità correlabili alla dinamica dell'evento. La società italiana che ha eseguito la manutenzione sul velivolo in data 29 aprile 2016 era in possesso delle previste certificazioni rilasciate dall'ENAC.

Al presente stato dell'inchiesta di sicurezza, gli elementi acquisiti a seguito degli accertamenti effettuati, presso il costruttore, sul carrello anteriore dell'aeromobile in questione, evidenzierebbero l'esistenza di una criticità riconducibile ad un improprio assemblaggio di alcuni componenti interni all'ammortizzatore dello stesso carrello (allegato "B").

Questioni di sicurezza

Le modalità con cui sono state eseguite le attività manutentive sul carrello anteriore, prima dell'evento, sono oggetto di approfondimenti in corso da parte dell'ANSV.

In particolare, l'attenzione dell'ANSV si sta concentrando sulla idoneità e sulla completezza delle informazioni fornite dall'AMM e sulle procedure di lavoro effettivamente seguite in occasione dell'ultima manutenzione dell'aeromobile.

Elenco allegati

Allegato "A": documentazione fotografica.
Allegato "B": accertamenti condotti presso il costruttore del carrello.

Nei documenti riprodotti in allegato è salvaguardato l'anonimato delle persone coinvolte nell'evento, in ossequio alle disposizioni dell'ordinamento vigente in materia di inchieste di sicurezza.

Allegato “A”

Foto 1: il velivolo fotografato poco dopo l’accadimento dell’evento.

Foto 2: danni alla parte inferiore della fusoliera.

Foto 3: posizione di rinvenimento dei due pneumatici.

Allegato “A”

Foto 4: posizione di rinvenimento del carrello anteriore dopo la rimozione del velivolo dalla pista.

Foto 5: la gamba del carrello anteriore prima dell’esame condotto presso il costruttore del componente.

Allegato “B”

Technical Event Investigation Report

Air Vallée (RVL) Fokker 50 MSN 20128 (SE-LEZ)

Nose Landing Gear Up Landing

SECTION 1. EXECUTIVE SUMMARY

On April 30th 2016 during a revenue flight from Rimmini to Catania Fontanarossa airport, the crew of Air Vallée Fokker 50 MSN 20128 (registration SE-LEZ) received an amber NLG caution light when attempting to deploy the gear. Both MLGs successfully down locked, but the NLG failed to extend from its retracted position. The aircraft subsequently landed on both MLGs with the NLG still retracted in the bay. The aircraft touched down on the fuselage at the nose. Passengers were evacuated and no injuries were reported.

It was reported that one day prior to the event, a seal replacement activity was performed by Air Vallée. The Shock Absorber was removed, disassembled, the Gland seals and Separator Piston seals were replaced and servicing of the Shock Absorber was also performed in accordance with the AMM prior to assembly and reinstallation.

A gear strip and investigation was carried out at Smiths Aerospace with Safran, ANSV and AAIB representatives present. Dimensional checks and visual examination for damage and correct installation conducted during the strip down. Oil levels and gas pressures were recorded.

The root cause was identified to be the incorrect assembly of the Valve Housing to the Sliding Member during a seal replacement activity just prior to the event. The resulting orientation of the Valve Housing meant that the dowels could fall through in to the Sliding Member, leading to a loss of the mechanical out stop of the Shock Absorber. Additional evidence of incorrect assembly was also observed in two Shock Absorber seal assembly locations. The Shock Absorber had also been overfilled by 407ml.

Safran technical publications (Ref. [1] and [2]) have been reviewed and are considered to be robust and written specifically to prevent incidences of incorrect assembly of the Valve Housing to the Sliding Member and thus to prevent overextension of the Sliding Member.

Safran does not consider that any corrective action is required as the published assembly instructions are considered to be robust and an incorrect assembly would manifest in a loss of out stop in a low number of cycles. As this has not been reported, it is considered that the rest of the fleet is correctly assembled.

SECTION 2. ACRONYMS AND ABBREVIATIONS

AAIB	Air Accidents Investigation Branch
AMM	Aircraft Maintenance Manual
ANSV	Agenzia Nazionale per la Sicurezza del Volo
CMM	Component Maintenance Manual
CSN	Cycles Since New
CSO	Cycles Since Overhaul
FTIR	Fourier Transform Infrared Spectroscopy
in^3	Cubic Inches
lb ft	Pound-foot
ml	Millilitres
MSN	Manufacturers Serial Number
MLG	Main Landing Gear
NLG	Nose Landing Gear
Nm	Newton Metres
P/N	Part Number
psi	Pounds per Square Inch
Ref.	Reference
SB	Service Bulletin

SECTION 3. TABLE OF CONTENTS

SECTION 3. EVENT REPORT

On April 30th 2016 during take-off from to from Rimmini to Catania Fontanarossa airport, the crew of Air Vallée Fokker 50 MSN 20128 (registration SE-LEZ) noticed an unusual sound during NLG retraction. At the time, this was not considered to have been an important issue.

On final approach to Catania, the air crew attempted to extend the NLG and received an amber caution light. The MLGs successfully down locked, confirmed by green lights in the cockpit. The crew declared its intention to proceed with the approach and perform a low pass in order that the condition of the NLG could be visually checked.

The low pass was performed and the control tower confirmed that the NLG doors were open, but the NLG was not deployed. The aircraft entered a hold for the air crew to proceed with troubleshooting by working through appropriate checklists. The gear could not be deployed.

A second low pass was performed for final visual confirmation of the condition of the NLG. The crew prepared for an emergency landing. The aircraft landed on both MLGs with the NLG still retracted in the bay. The aircraft touched down on the fuselage at the nose and the emergency evacuation procedures were performed. Passengers were evacuated and no injuries were reported.

Maintenance records provided by Air Vallée (Refer to Appendix A) indicate that one day prior to the event, a seal replacement activity was performed. The Shock Absorber was removed, disassembled and the Gland seals and Separator Piston seals were replaced. Servicing of the Shock Absorber was also performed in accordance with the AMM prior to assembly and reinstallation.

SECTION 4. IDENTIFICATION AND DESCRIPTION

a. Unit: Nose Landing Gear
b. Part Number: 201013001
c. Serial Number: DRG/2586/87
d. CMM: 32-20-43
e. Unit Cycles: 1872 CSO (due to doubts with the data provided by Air Vallée, the accurate CSN cannot be provided at this time)
f. Aircraft Type: Fokker 50
g. Aircraft number: MSN 20128 (Registration SE-LEZ)
h. Date of incident: 30th April 2016
i. Operator: Air Vallée

The NLG is a steerable, twin axled, retractable unit that includes an oleo-pneumatic shock absorber and a hydraulically operated rack and pinion type steering mechanism. Figure 1 shows a general illustration of the NLG.

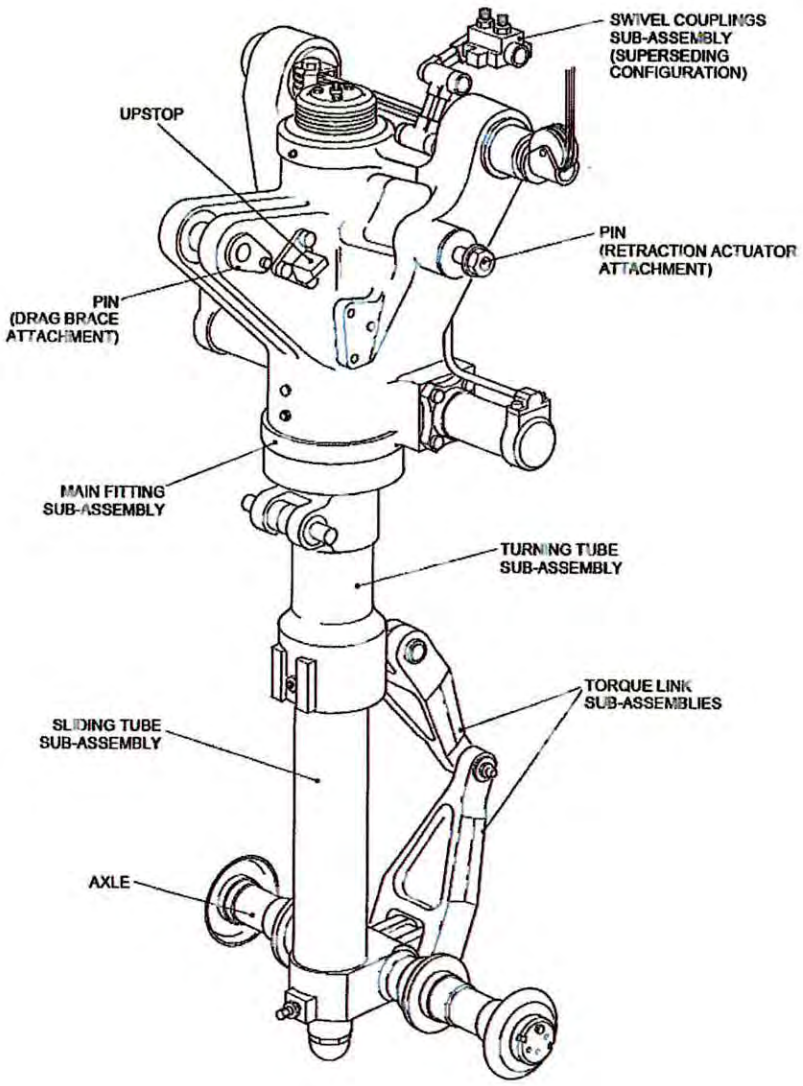

FIGURE 1: FOKKER 50 NOSE LANDING GEAR

The shock absorber is comprised of the Turning Tube Sub-Assembly (forming the upper component of the shock absorber) and the Sliding Member Sub-Assembly (forming the lower component of the shock absorber).

The Sliding Member moves in the turning tube through the sealed nut and bearing sub-assembly, installed in the lower end of the turning tube sub-assembly. A bearing and a valve are installed at the upper end of the Sliding Member sub-assembly.

The out stop sub-assembly, screwed into the turning tube, limits the extension of the Sliding Member by contacting the Bearing Sleeve and upper bearing.

The valve comprises a Valve Housing which is drilled for fluid flow, a retaining nut, a spring and a valve. A flanged Bearing Sleeve and bearing are installed at the upper end of the Sliding Member. Four dowels hold the Valve Housing and the Bearing Sleeve to the Sliding Member sub-assembly.

A sealed piston operates in the bore of the Sliding Member sub-assembly and separates the nitrogen and fluid contents of the shock absorber. Figure 2 shows a cutaway view of the shock absorber.

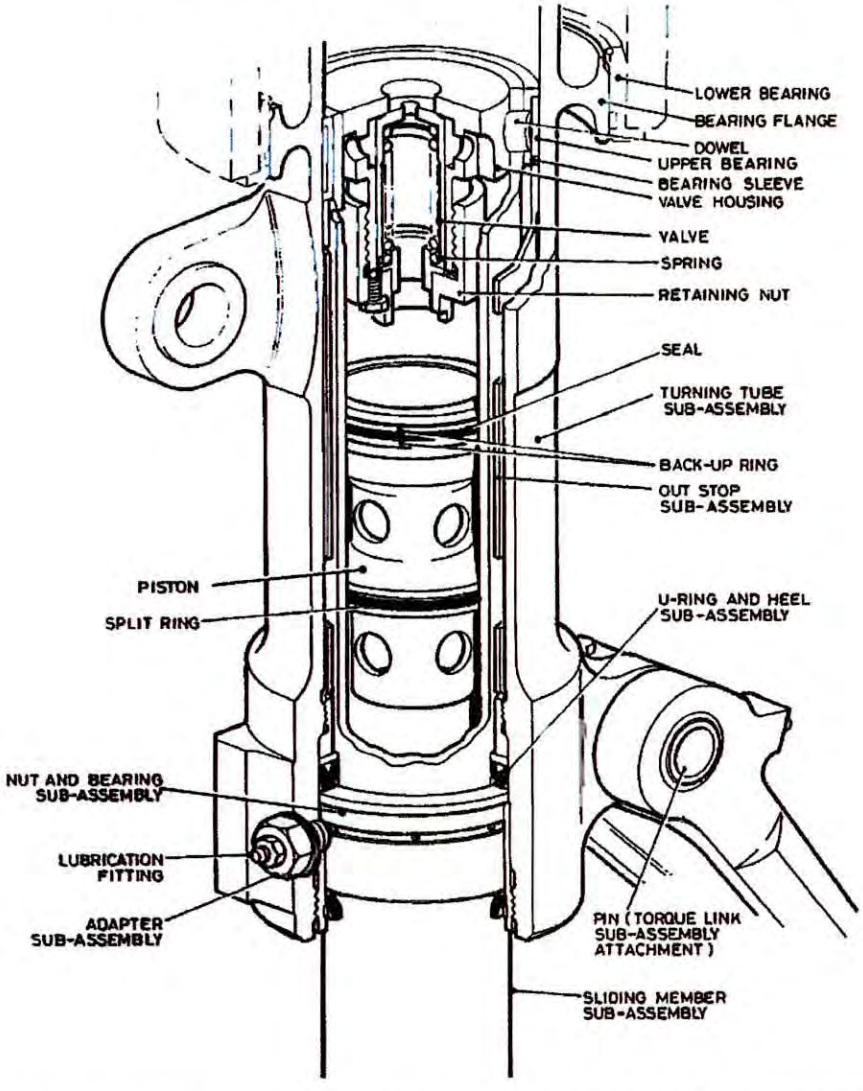

FIGURE 2: CUTAWAY VIEW OF NOSE LANDING GEAR SHOCK ABSORBER

Shock Absorber Function (refer to figure 3)

Compression

When a compressive load is applied, the Sliding Member sub-assembly moves up inside the turning tube sub-assembly. This action decreases the volume for the fluid in the turning tube sub-assembly. The pressurized fluid opens the valve in the Sliding Member sub-assembly and flows into the Sliding Member sub-assembly through the large hole in the centre of the Valve Housing. The piston in the Sliding Member sub-assembly is pushed down to further compress the nitrogen. The progressive resistance of the nitrogen together with the restriction to fluid flow absorbs the compression load.

Recoil

When the compressive load is removed from the Sliding Member sub-assembly, the nitrogen, now under high pressure, forces the piston up the Sliding Member which causes the fluid in the Sliding Member to flow back into the turning tube. The valve in the Sliding Member is held closed by spring pressure and allows fluid to flow only through the small hole in the centre of the valve. This further restriction to fluid flow reduces the speed of recoil providing the required damping action.

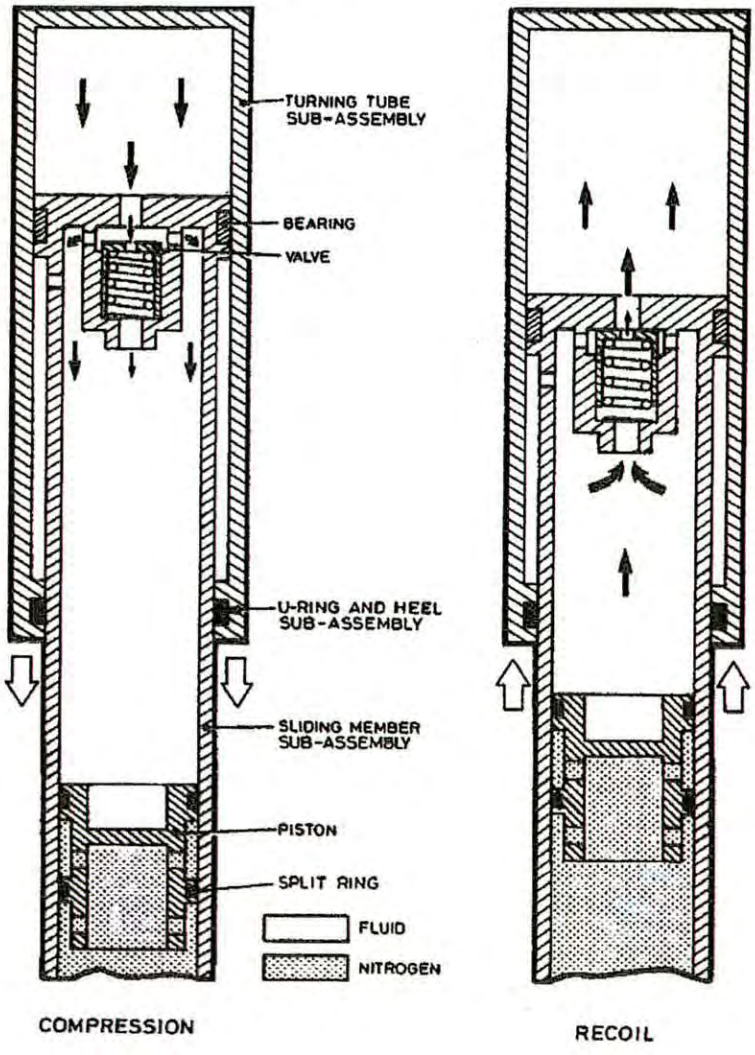

FIGURE 3: NOSE LANDING GEAR SHOCK ABSORBER FUNCTIONAL DIAGRAM

SECTION 5. INVESTIGATION

5.1 Disassembly and Inspection

The NLG was shipped to Smiths Aerospace, where it was quarantined in received condition until the investigation proceeded. The activity took place 21st – 22nd June 2016, with AAIB, ANSV and Safran Landing Systems representatives in attendance.

The box was opened and it was immediately noticed that the support blocks had been extended inside the carrier to accommodate the over-extended gear. The Torque Links were fully extended to a straightened position. There was no external evidence of damaged components. A measurement was taken between the gland nut and the end of the chrome plating on the slider with the gear still boxed: the measurement was recorded as 16 5/8 inch (422,3mm). By comparison, the same measurement was taken later with the Out Stop assembled and the dowels in place and was recorded as 13 ¾ inch (349,25mm). The general condition of the NLG was considered to be normal other than the position of the Torque Links and Sliding Member (Refer to Figure 4).

FIGURE 4: NOSE LANDING GEAR IN BOXED CONDITION

With the gear still boxed, the nitrogen pressure was tested using an analogue gauge to the inflation valve and was recorded to be 140psi as opposed to the correct value of 185-195psi (Refer to Figure 5). The ANSV stated that they had requested than the NLG be transported without altering the pressure of the gear from the installed condition.

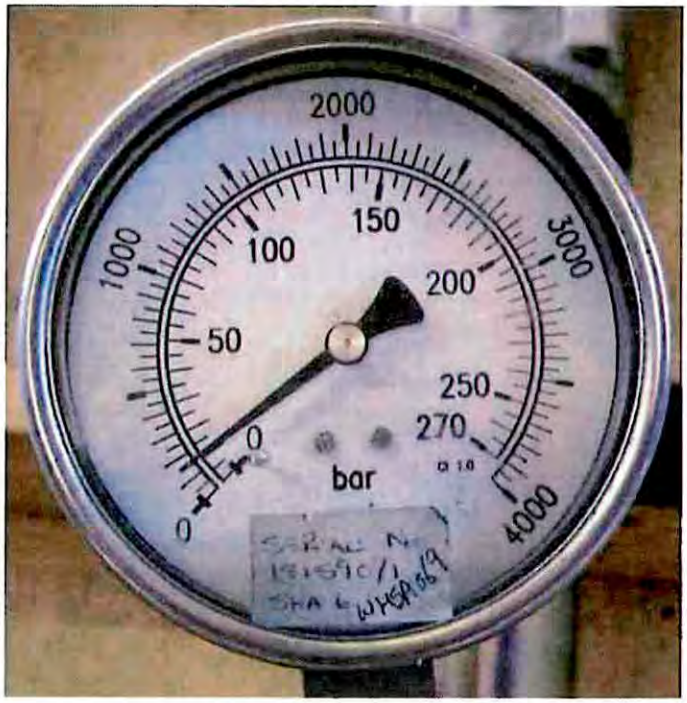

FIGURE 5: NLG NITROGEN PRESSURE READING

The gear was removed from the box using a sling on a gantry, and was placed on a workbench in preparation for hydraulic fluid draining. The oil filler bolt was removed, and the gear was inverted to allow the hydraulic fluid to drain in to a clean container. The amount of oil measured was 2700ml compared to the design volume of 2293ml (139.94in^3). Thus, the Shock Absorber had been overfilled by 407ml. The oil appeared to be clean (a sample was taken for laboratory analysis).

The gear was returned to a horizontal position on the workbench in preparation for removal of the Sliding Member. The gland nut retaining bolt had been over-torqued (30-35 lb ft as opposed to the drawing required 13.3-14.8 lb ft (18-20Nm)). As the slider was being removed, excessive play was noticed suggesting that the upper bearing had become detached from the Sliding Member. Some metallic debris was collected from the turning tube after removal of the slider and retained for laboratory analysis.

With the Sliding Member removed, the Valve Housing, the piston and the retaining dowels were visible in the top of the turning tube (Refer to Figure 6). These components were removed from the turning tube for further examination. There were no signs of a fracture or evidence of crack upon visual examination. The Valve Housing showed witness marks in the damping orifice slots, suggesting that the Valve Housing had been assembled in the incorrect orientation. Scribing marks were evident on the Sliding Member (P/N 201013304), Valve Housing (P/N 201013715) and Bearing Sleeve (P/N 201013734) indicating that this was a superseding installation according to Service Bulletin F50-32-60 (Ref. [1]). The identification marking on the Sliding Member was only visible under ten times magnification with a hand lens.

FIGURE 6: TURNING TUBE INNER BORE WITH PISTON, VALVE HOUSING AND RETAINING DOWELS VISIBLE

The identification marking that had been mechanically scribed on to the Bearing Sleeve was not a requirement of Ref. [1]. However, the scribed line was noticed to be facing the opposite direction to those scribed on the Sliding Member and the Valve Housing; it was upside down by comparison. It is believed that the significance of the scribed markings on the Valve Housing and the Sliding Member was not understood, and that the maintenance staff performing the seal replacement just prior to the incident did not notice that the Valve Housing was assembled in the incorrect radial orientation.

Examination of the seal assemblies was carried out. The Backing Ring from the Gland U-Ring and Heel Sub-Assembly (P/N 333-016-2454-41) was found to be installed in the wrong orientation. Additionally the backing rings (P/N 717042562) on the separator piston were installed upside down. Figure 7 highlights the position of the incorrectly installed sealing assemblies.

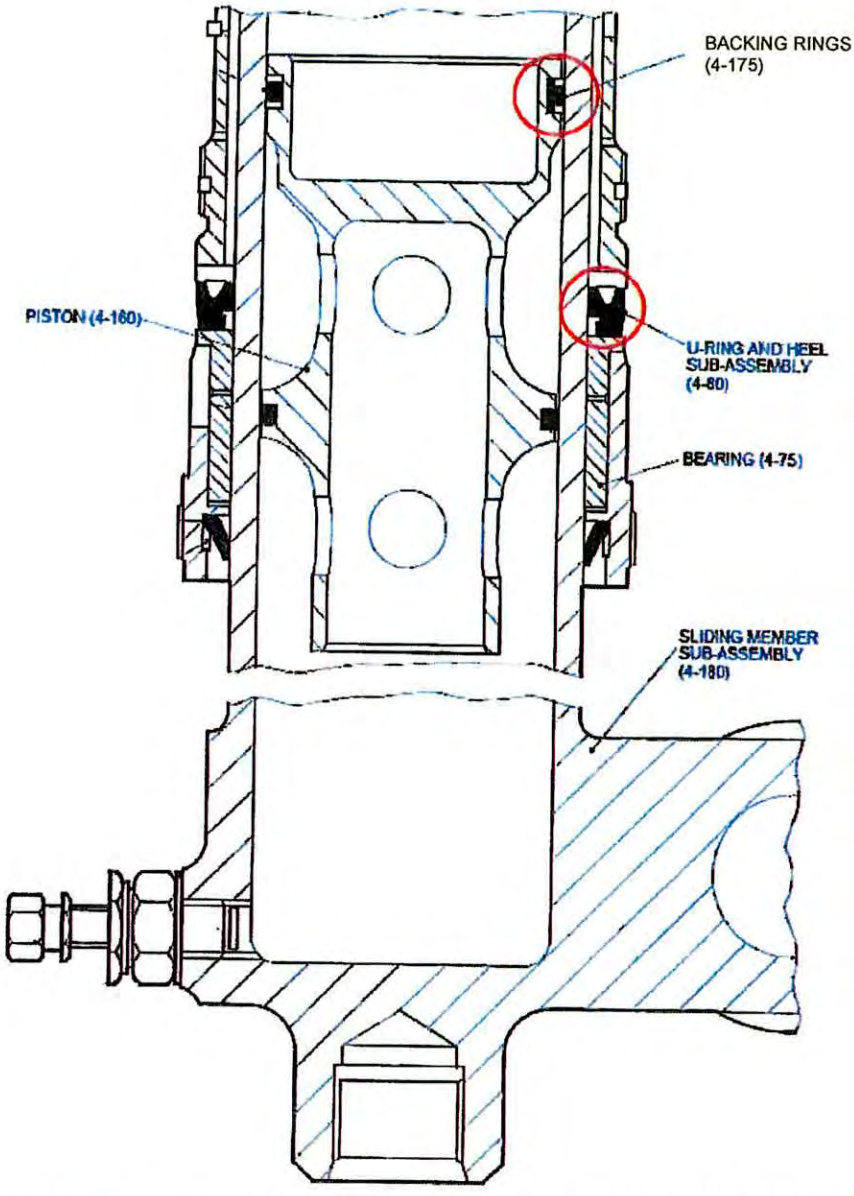

FIGURE 7: DIAGRAM HIGHLIGHTING POSITION OF INCORRECTLY INSTALLED SEALS WITHIN THE SLIDING MEMBER SUB-ASSEMBLY

As part of further examination of the Torque Links, an abnormal level of play was observed between the threads of the Torque Link Apex Bolt and the Torque Link Apex Nut.

5.2 Dimensional Checks

Dimensional checks were performed against the Fits and Clearances section of Ref [2]. The results are presented in Table 1 below, and a diagram of the components is shown in Figure 8.

Component (P/N)		Initial Manufacturing Limits mm (in)		In-Service Wear Limits mm (in)		MSN 20128 NLG Measured Dimension mm (in)	
		Min.	Max.	Min.	Max.		
Retaining Dowel (201013714)	OD	12,657 (0.4983)	12,685 (0.4994)	12,609 (0.4964)	12,685 (0.4994)	1	**12,657 (0.4983)**
						2	**12,662 (0.4985)**
						3	**12,652 (0.4981)**
						4	**12,639 (0.4976)**
Valve Housing (201013715)	OD	66,221 (2.6071)	66,240 (2.6079)	66,137 (2.6038)	66,240 (2.6079)	**66,200 (2.6063)**	
	Dowel Hole Ø	12,70 (0.50)	12,718 (0.5007)	12,70 (0.50)	12,776 (0.5030)	1	**12,736 (0.5014)**
						2	**12,746 (0.5018)**
						3	**12,743 (0.5017)**
						4	**12,736 (0.5014)**
Bearing Sleeve (201013734)	ID	72,529 (2.8555)	72,559 (2.8566)	72,529 (2.8555)	72,608 (2.8586)	**72,527 (2.8554)**	
	Dowel Hole Ø	12,70 (0.50)	12,718 (0.5007)	12,70 (0.50)	12,776 (0.5030)	1	**12,720 (0.5008)**
						2	**12,718 (0.5007)**
						3	**12,725 (0.5010)**
						4	**12,725 (0.5010)**
Sliding Member (201013304)	OD	72,50 (2.8543)	72,519 (2.8551)	72,440 (2.8520)	72,519 (2.8551)	**72,479 (2.8535)**	
	ID	66,250 (2.6083)	66,296 (2.6101)	66,250 (2.6083)	66,353 (2.6124)	**66,281 (2.6095)**	
	Dowel Hole Ø	12,70 (0.50)	12,718 (0.5007)	12,70 (0.50)	12,776 (0.5030)	1	**12,738 (0.5015)**
						2	**12,743 (0.5017)**
						3	**12,728 (0.5011)**
						4	**12,738 (0.5015)**

TABLE 1: RESULTS OF DIMENSIONAL CHECKS AGAINST FITS AND CLEARANCES

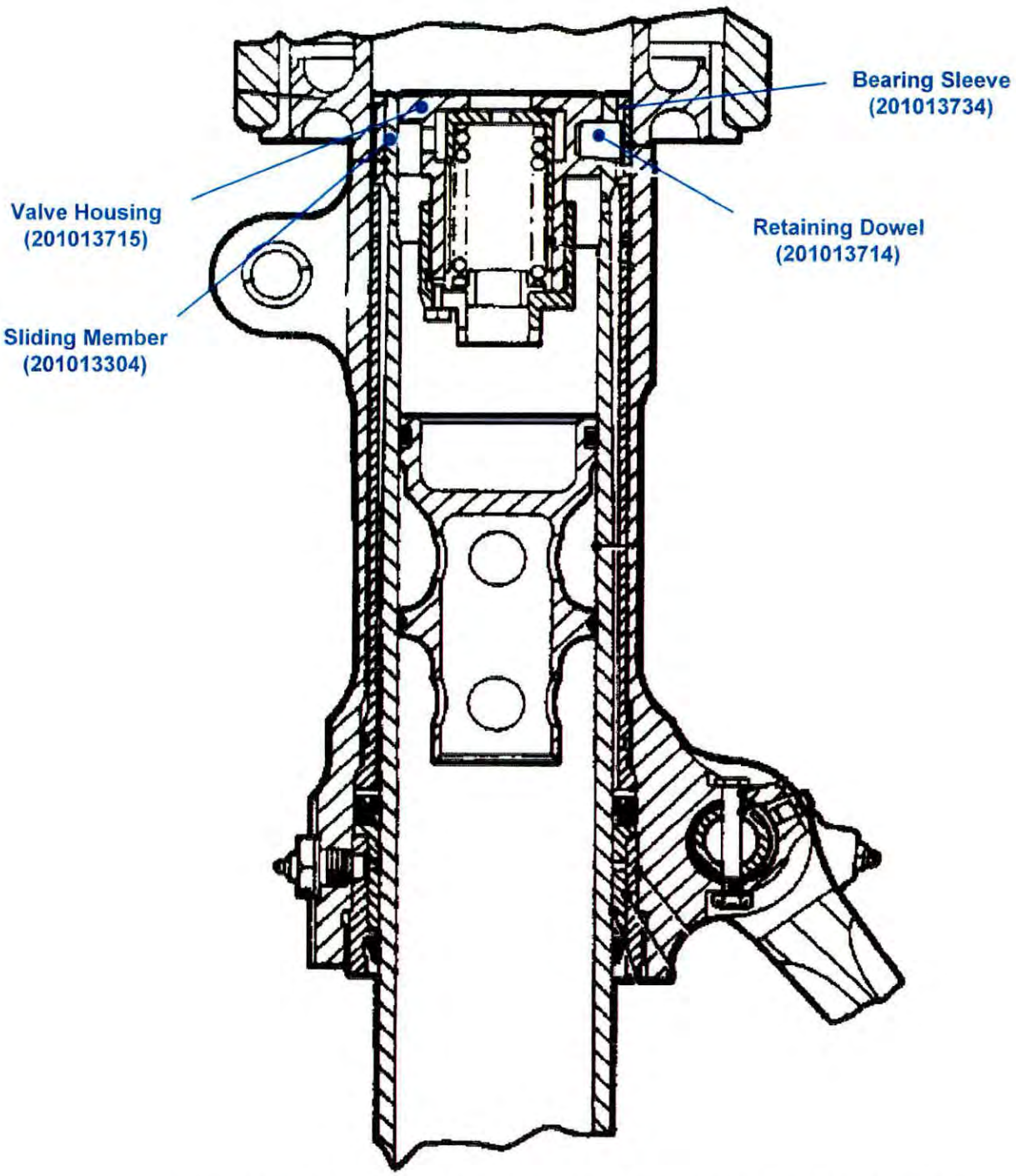

FIGURE 8: DIAGRAM SHOWING MEASURED COMPONENTS LISTED IN TABLE 1

The numbered references of the each retaining dowel and each dowel hole in the Valve Housing, Bearing Sleeve and Sliding Member refer to the same numbered positions mentioned in Appendix C. All measurements taken were in line with the Fits and Clearances section In-Service Wear Limits detailed in Ref [2].

5.3 Technical Publications Review

Refer to Appendix B: *Extract from CMM 32-20-43*

A review of the CMM (Ref. [2]) and applicable SB (Ref. [1]) was carried out to ensure that the technical publications contained sufficient instruction to prevent the incorrect assembly witnessed during the strip down activity. The review also investigated the publications to confirm that the requirements of the SB had been clearly incorporated in the CMM.

The SB (Ref. [1]) was released in January 1996. It contains instructions to engrave identification marks on the valve housing and sliding member to ensure that they are correctly aligned. As a result of the SB release, the CMM was updated to reflect the requirements of the SB. On page 718 of the assembly section of (Ref. [2]) there is a clear and emboldened caution note (clearly drawing reference to the IPL references of the specific parts) to prevent incorrect alignment of the Bearing Sleeve, Valve Housing and Retaining Dowels:

'CAUTION: ENSURE CORRECT ALIGNMENT OF BEARING SLEEVE (4-125A), VALVE HOUSING (4-155) AND DOWELS (4-120). MAKE SURE THAT YOU DO NOT INSERT THE DOWELS IN THE DAMPING ORIFICE CUT OUTS INSTEAD OF THE DOWEL HOLES.'

Additionally, on page 718 of the assembly section of (Ref. [2]), assembly step (11) states:

'On superseding installations a line is engraved on the Sliding Member (4-95) and on the top face of the Valve Housing (4-155) to indicate the centre line of one dowel hole dowel (4-120). These engraved lines will assist in the correct alignment of the Valve Housing (4-155), Bearing Sleeve (4-125) and Sliding Member sub-assembly.'

Safran have no record of previous cases of incorrect assembly of the Valve Housing in the Shock Absorber. The Service Bulletin was therefore not introduced as a result of a previous case.

As a result of the review, Safran considers there to have been a sufficient detail contained in the CMM (which is in harmony with the SB) to prevent the incorrect alignment of the Bearing Sleeve, Valve Housing and Retaining Dowels during assembly of the Shock Absorber.

5.4 Materials Laboratory Investigation

Refer to Appendix C: *Safran Materials & Processes Report 16/4065 Issue 2*

Findings Associated with Occurrence

- Evidence of wear/scratching was observed in various locations on the outside diameter of the Valve Housing (refer to Figure 9)
- Circular scratches were observed in one orifice slot (refer to Figure 10)
- All four orifice slots contained scratches on the inner wall of the slot (refer to Figure 10)
- The Torque Link Apex Nut threads did not pass the Go-No Go test. Sectioning of the nut revealed an incorrect thread form.
- The hydraulic fluid sample was analysed using FTIR before and after filtration. The traces confirmed the hydraulic fluid to be mineral oil in accordance with MIL-5606. The water content was measured to be 41ppm, which is acceptable to PCS-7100.

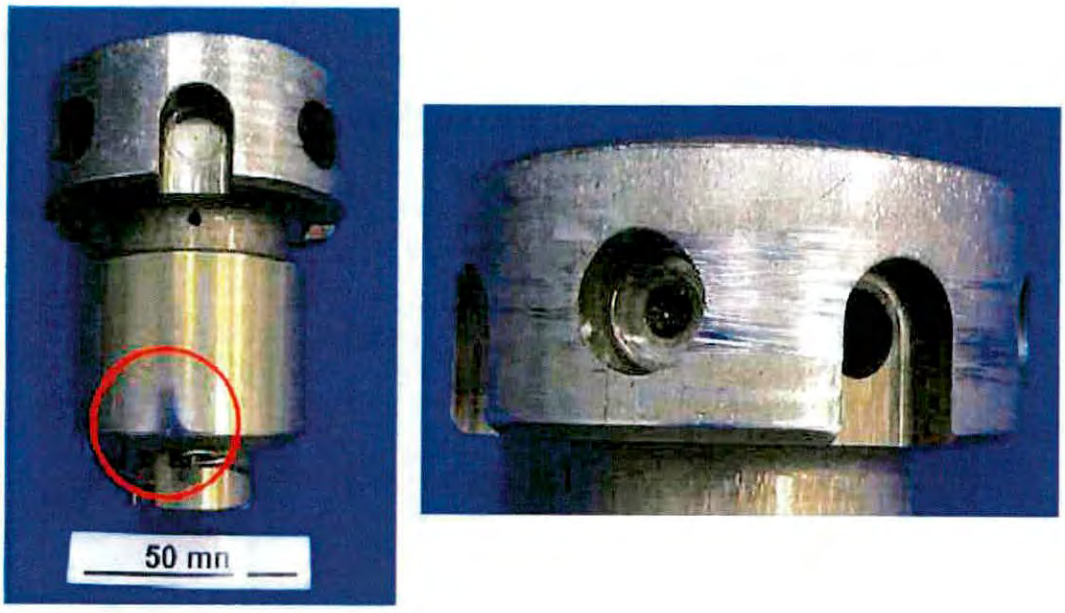

FIGURE 9: WEAR/SCRATCH DAMAGE TO OUTSIDE DIAMETERS OF VALVE HOUSING

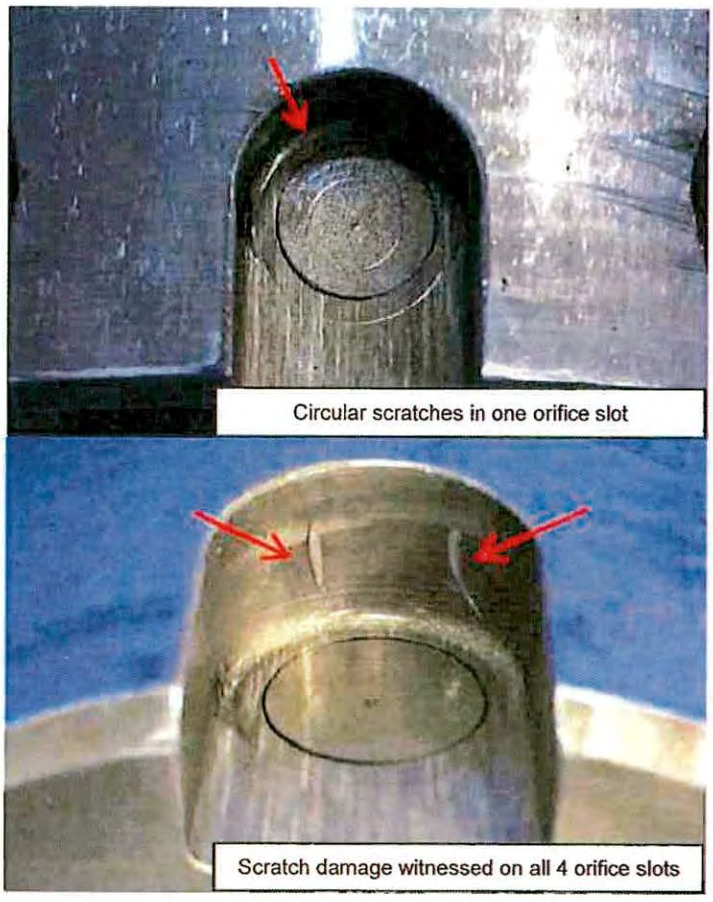

FIGURE 10: SCRATCH DAMAGE TO ORIFICE SLOTS OF VALVE HOUSING

Conclusions

- Damage observed on the Valve Housing supports the conclusion of incorrect assembly causing the over-extension of the NLG. The damage witnessed to the valve housing suggests that the retaining dowels were assembled into the orifice slots rather than the dowel holes.
- The Torque Link Apex Nut thread did not conform to the design thread specification of ¾"-16UNF-2B, explaining the excessive play observed between the nut and bolt. This is not considered to be significant, as the excessive play would not contribute to loss of mechanical Out Stop in the Shock Absorber and thus was not contributory to the root cause.
- Fluid analysis confirmed that the oil used in the Shock Absorber was mineral oil with acceptable water content.

SECTION 6. ROOT CAUSE

One day prior to the event, a seal replacement activity was performed as a solution to a hydraulic leak witnessed by Air Vallée operatives. During the seal replacement, the Valve Housing was assembled in the incorrect orientation, such that the Retaining Dowels did not pass through the dowel holes in the Valve Housing and Sliding Member. Instead, the Retaining Dowels were aligned to the damping orifice slots in the Valve Housing. The damage to the orifice slots of the Valve Housing described in Appendix C supports the findings witnessed during the shop visit detailed in Section 5.1.

The resulting orientation of the Valve Housing meant that the component would not have been retained by the Dowels. During operation, the Valve Housing was pushed upwards from the Sliding Member into the Turning Tube, allowing the dowels to fall through in to the Sliding Member. This resulted in a subsequent loss of the mechanical out stop of the Shock Absorber.

During NLG retraction after Air Vallée MSN 20128 took off from Rimmini Airport, the loss of mechanical out stop lead to overextension of the Shock Absorber and thus straightening of the Torque Links. As the gear completed the retraction cycle, the overextension of the Shock Absorber caused the wheel to impact the bulkhead. This impact was heard by the flight crew. Upon impact the spinning wheel assisted to push the gear into a fully retracted position, but with the wheel jammed against the bulkhead. As the gear was fully retracted in the bay, the avionics did not show indications of a problem with the NLG retraction cycle and thus the crew assumed a normal retraction.

When the attempt was made to deploy the NLG on approach to Fontanarossa Airport, the contact between the tyre and the bulkhead meant that the gear could not be extended. In addition the straightened position of the Torque Links would have acted to stop the Sliding Member from closing on the attempt to lower the NLG; therefore the NLG could not be released from the jammed position and remained in the up position.

SECTION 7. CONCLUSION

The root cause of the NLG failing to extend was the incorrect assembly of the Valve Housing to the Sliding Member during a seal replacement activity just prior to the event. The root cause is supported by findings from both a gear strip activity (Refer to Section 5.1) and a Safran Materials and Processes Report (Refer to Section 5.4 and Appendix C). Evidence of incorrect assembly was also observed in two seal assembly locations. The Shock Absorber had also been overfilled by 407ml. Additional evidence (Refer to Appendix D) shows that the Air Vallée's maintenance provider ordered the list of tooling required to perform the seal replacement after they had completed the job (seal replacement was carried out 29/04/2016 and the request for tooling was made 01/06/2016). This suggests that the maintenance provider did not have the correct tooling to perform the seal replacement carried out on 29/04/2016 and that they were not following the applicable manuals.

Safran technical publications (Ref. [1] and [2]) have been reviewed and are considered to be robust and written specifically to prevent incidences of incorrect assembly of the Valve Housing to the Sliding Member, and thus to prevent overextension of the Sliding Member.

Safran does not consider that any corrective action is required as the published assembly instructions are considered to be robust and an incorrect assembly would manifest in a loss of out stop in a low number of cycles. As this has not been reported, it is considered that the rest of the fleet is correctly assembled.

SECTION 8. REFERENCES

	Reference	Issue /Revision	Title
[1]	Service Bulletin F50-32-60	1	Landing Gear – Nose Landing Gear – Identification Marks For Correct Assembly of Valve Housing in Sliding Member
[2]	Component Maintenance Manual 32-20-43	24	Nose Landing Gear Part Number 201013001 - Component Maintenance Manual With Illustrated Parts List
[3]	Materials and Processes Report 16/4065	2	Fokker F50 NLG Valve Housing

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Appendix A

NLG DRG/2586/87 Maintenance record since January 2014

(3 Pages)

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2.0 Maintenance on NLG since January 2014

Work report	ATA	Description	Action taken	Date	P/N off	S/n off	P/n on	S/n on	A/c TSN	A/c CSN
LEZ 030	32	Both nose wheel tires worn to limit.	Both nose wheel assy replaced iaw F50 MM 32-41-00 satisf.	27/08/14	5007998 5007998	AUG89-0373 DEC-94-0825	5007998 5007998	OCT 94-0833 FE892-0687	37637:16	44066
LEZ 088	32	Found L/H and R/H Nose wheel tyres worn	L/H and R/H Nose wheels replaced	23/06/15	5007998 5007998	OCT94-0833 FEB92-0887	5007998 5007998	OCT99-1003 AUG89-0373	37871:53	44380
LEZ 15/049	27/32	TASK322100-00-04: NOSE LANDING GEAR - LUBRICATION OF NOSE LANDING GEAR.	NLG lubrication performed	23/06/15	-	-	-	-	37871:53	44380
LEZ 15/124	5	Nose landing Gear - Lubrication of Nose landing gear	Lubrication of Nose Landing Gear perf. Satisf	22/10/15					37147:49	44702
LEZ 135	32	Nose wheel W.T.L	Nose wheel assy replaced iaw F50 AMM 32-41-00-000-824 & F50 AMM 32-41-00-400-824 on ground satisf	22/10/15	5007998 5007998	AUG89-0373 OCT99-1003	5007998 5007998	AUG89-0389 NOV87-127	37147:49	44702
LEZ 189	32	BOTH LH AND RH NOSE WHEEL TIRES WORN TO LIMIT	BOTH LH AND RH NOSE WHEEL ASSY'S REPLACED	18/02/16	5007998 5007998	NOV87-127 AUG89-0389	5007998 5007998	MAR89-0295 APR89-0321	38547:29	45012
LEZ 193	32	MX ENTRY: HYD LEAK AT R/H NLG SEQ. VLAVE UNION FITTINGS	REPLACED 2ea O'RINGS AT UNION FITTINGS - CHKD OK. NO LEAKS.	06/03/16	MS28778-6	NSN	MS28778-6	NSN	38614:22	45065
LEZ 16/066	32	TASK322100-00-04: NOSE LANDING GEAR - LUBRICATION OF NOSE LANDING GEAR.	LUBE OF NOSE LG PERFORMED SATISFACTORY IAW JCM 322100-00-04	13/04/16					38777:52	45182
LEZ 213	32	After landing in Tirana we noticed short vibration on the nose gear and after arrival on parking stand TI we found the NLG strut was completely down to the stop	Ref DC LEZ 213: Found hydraulic leak from NLG strut after landing. Cleaned NLG strut did full service ref AMM 12-13-05-610-853-A. Satisfy	28/04/16					38820:24	45213
LEZ 16/089	32	Perfom following action issued by engineering department. Following malfunction on tech 026 log 000018 dated 22/04/2016, for caution: 1)Perform removal/installation of sliding member and gland seal. 2)Perform removal/installation of Separator piston 3)Perform servicing of NLG iaw AMM 12-13-05-610-853-A	Perfom following action issued by engineering department. Following malfunction on tech 026 log 000018 dated 22/04/2016, for caution: 1)Perform removal/installation of sliding member and gland seal removed. 2)Separator piston removed and seal replaced 3)Separator piston installed and sliding member gland seal installed. IAW AMM 32-21-05-000-814A and 32-21-06-000-824-A, 32-21-06-400-	29/04/16	750540704 201013610 201013610 201013609 333-016-2454-41		750540704 201013610 201013610 201013609 333-016-2454-41		38822:42	45214

10/05/2016

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Appendix B

Component Maintenance Manual 32-20-43 Extract

(3 Pages)

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K. Fit the sliding member sub-assembly (4-180) to the turning tube sub-assembly (6-70) as follows:

(1) On Pre SB F50-32-54 units, using the Assembly Post 460005794, fit the seal (4-170) and the backing rings (4-175). Using the Keep Ring 460003180/58, resettle the backing rings. On Post SB F50-32-54 units, fit the T-seal assembly (4-177).

(2) Cut the split ring (4-165) to have a fitted gap of between 0,23 and 0,30 mm (0.009 and 0.012 in) with the sharp edges radiused to between 0,13 and 0,38 mm (0.005 and 0.015 in). Fit the split ring (4-165).

(3) Fit the piston (4-160) into the sliding member sub-assembly (4-180).

(4) Fit the bearing (4-75) to the nut (4-70): refer to M-DLPS1011-5 (less sealant M-DLPS709-9 or M-DLPS709-10). Assemble the spacer (4-95) and wiper ring (4-90) to the nut and bearing sub-assembly (4-65).

(5) Slide the nut and bearing sub-assembly (4-65) onto the sliding member sub-assembly (4-180).

(6) Slide the U-ring and heel sub-assembly (4-80) and the seal washer (4-85) onto the sliding member sub-assembly (4-180): refer to Figure 710.

(7) Fit new plugs (4-105) into the outstop (4-110) and slide the outstop sub-assembly (4-100) onto the sliding member sub-assembly (4-180).

(8) Restrain the valve housing (4-155) in the Holding Block MT1026/56 and Bench Clamp MT1025. Using the Spring Compressor 460005795, fit the valve (4-150), the spring (4-145), the spring guide (4-140) and the retaining nut (4-135).

(9) Using the Tube Spanner 460001682/76, screw the retaining nut (4-135) fully on and turn back until the next available slot is in line with the bolt hole. Lubricate the threads of the screw (4-130) with hydraulic fluid, Material Ref. Item Fk02-002, fit and torque tighten to 3,05 N m (2,2 lbf ft).

(10) Lock the screw (4-130) to the retaining nut (4-135) using lockwire, Material Ref. Item Fk05-046.Ensure that the tail of the lockwire is positioned inside the recess in the bottom of the retaining nut (4-135) to prevent fouling between the piston (4-160) and the lockwire.

CAUTION: ENSURE CORRECT ALIGNMENT OF BEARING SLEEVE (4-125A), VALVE HOUSING (4-155) AND DOWELS (4-120). MAKE SURE THAT YOU DO NOT INSERT THE DOWELS IN THE DAMPING ORIFICE CUT OUTS INSTEAD OF THE DOWEL HOLES.

(11) Insert the assembled valve details into the sliding member sub-assembly (4-180) and fit the bearing sleeve (4-125) onto the sliding member sub-assembly. Align the dowel holes and insert the dowels (4-120). On superseding installations a line is engraved on the sliding member (4-95) and on the top face of the valve housing (4-155) to indicate the centre line of one dowel hole dowel (4-120). These engraved lines will assist in the correct alignment of the valve housing (4-155), bearing sleeve (4-125) and sliding member sub-assembly.

(12) Fit the upper bearing (4-115).

(13) Lubricate the threads of the charging valve (4-5) with hydraulic fluid, Material Ref. Item Fk02-002, and fit the washer (4-10) and the charging valve (4-5). Torque tighten the charging valve (4-5) to between 15,0 and 17,0 N m (11.1 and 12.5 lbf ft).

(14) Submit the sliding member sub-assembly (4-180) to the Piston Leakage Test as detailed in TESTING AND FAULT ISOLATION.

(15) Fit the Split Ring 460005796 into the bottom of the turning tube sub-assembly (6-70) to guide the sliding member sub-assembly (4-180). Slide the sliding member sub-assembly (4-180) into the turning tube sub-assembly (6-70). Remove the Split Ring 460005796.

(16) Screw in the outstop sub-assembly (4-100) and using the Spanner 460005797, torque tighten to 34,0 N m (25.0 lbf ft).

(17) Screw in the nut and bearing sub-assembly (4-65). Using the Spanner 460005798, torque tighten to 34,0 N m (25.0 lbf ft) then turn back to allow the adapter sub-assembly (4-45) to align with the first slot.

(18) Fit the washer (4-60), screw in the adapter (4-55) and torque tighten to between 18,0 and 20,0 N m (13.3 and 14.7 lbf ft). Fit the lubrication fitting (4-50) and charge with grease, Material Ref. Item Fk04-002, and ensure the grease-ways are clear.

(19) Fit the Sleeve 460005922 and slide the spacers (4-40) onto the axle using Loctite, Material Ref. Item 08-053, in accordance with M-DLPS709-6. Remove the Sleeve 460005922.

(20) Temporarily fit the collars (4-35), the axle nuts (4-30), the washers (4-25) and the bolts (4-20).

NOTE: These items will be finally assembled on fitment of nose wheels to the nose landing gear.

(21) Fit the jacking dome (4-15A) and torque tighten to 50,0 N m (36.8 lbf ft). Apply a fillet of sealant, Material Ref. Item Fk09-002, between the jacking dome and the sliding member sub-assembly (4-180).

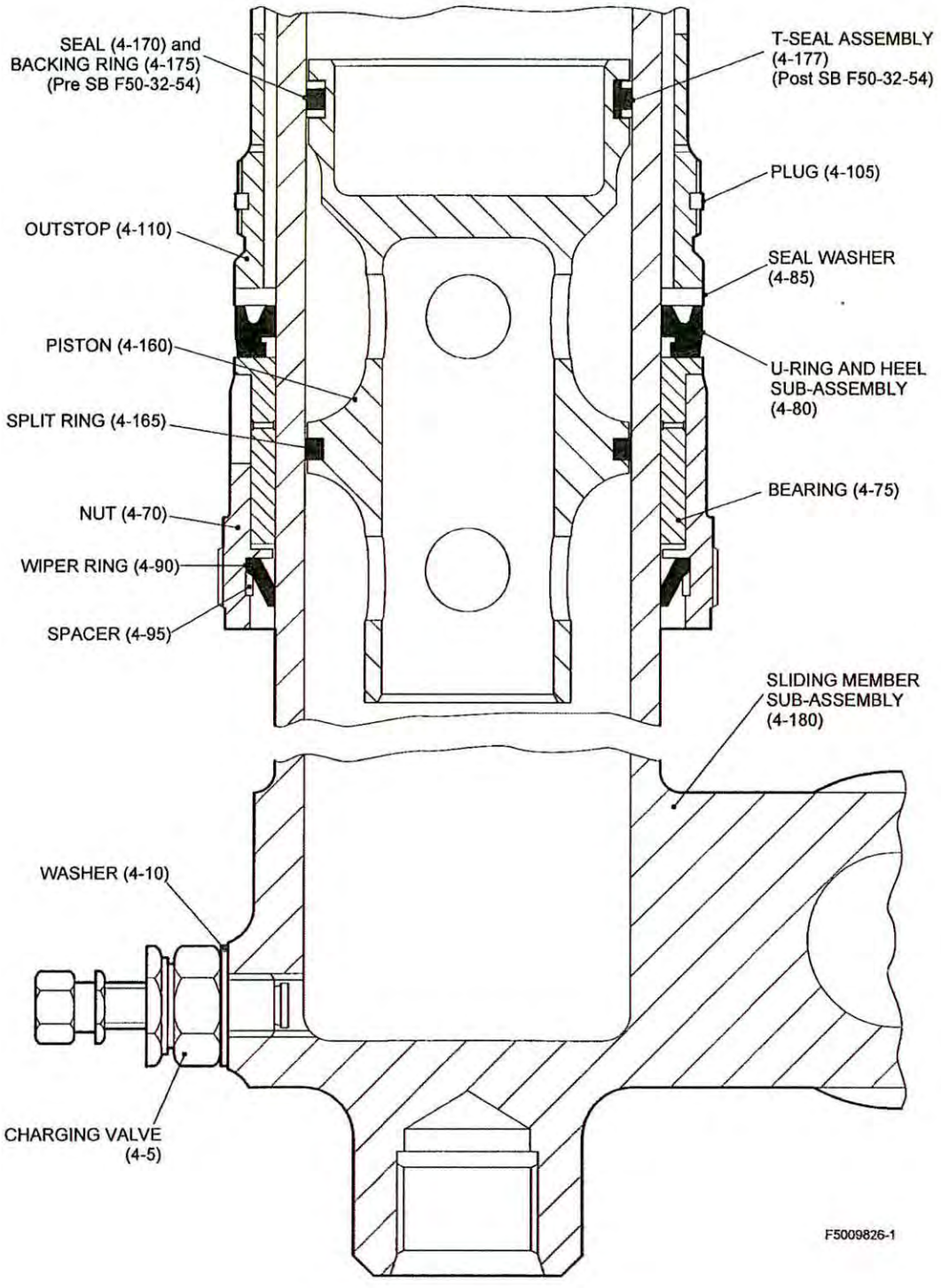
L. Fit the torque link sub-assemblies (3-60) to the turning tube sub-assembly (6-70) and the sliding member sub-assembly (4-180) as follows:

(1) Position the torque link sub-assemblies (3-60) and insert the pins (3-55) aligning the locking bolt holes. On superseding installations fit the bung (3-57).

(2) Fit the bolts (3-50), a maximum of four washers (3-45) and the nuts (3-10). Torque tighten the nuts (3-10) to between 5,0 and 10,0 N m (3.7 and 7.3 lbf ft).

(3) Fit the split pins (3-5).

(4) Fit the pin (3-35), the distance pieces (3-40) and the nut (3-20). Fit the lubrication fitting (3-30) and charge with grease, Material Ref. Item Fk04-002, and ensure the grease-ways are clear.



U-Ring and Heel Sub-assembly
Figure 710

TE-GL-00153721 Technical Event Investigation Report

Appendix C

Safran Materials and Processes Report 16/4065

(9 Pages)

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Report

MATERIALS & PROCESSES REPORT	16/4065	ISSUE 2

SUBJECT: Fokker 50 NLG Valve Housing

PART NUMBER: 201013001 (NLG – see itemised P/N below)

SERIAL NUMBER: DRG/2586/87

REFERENCE: TE-GL-00153721

SUBMITTED BY: P.S.E. Glos; 5th July 2016

HISTORY

On approach to Catania Airport, on 30th April 2016, an Air Vallée Fokker 50 (A/C no. 20128) was unable to extend its NLG, resulting in the aircraft touching down on the fuselage at the nose of the aircraft. The issue with the extension is thought to have been due to the over-extension of the gear during take-off, resulting in the gear becoming jammed in the bay. The day before the incident, a seal change had been performed on the NLG. The NLG had completed 1,872 CSO, but information regarding CSN was not provided.

Disassembly of the gear was performed at Smiths Aerospace. Initial conclusions were that the valve housing had been assembled incorrectly. A number of parts and samples were retrieved from the strip down and sent to the Materials & Processes Laboratory Gloucester for examination (see Table 1 for details). The valve housing is manufactured from Aluminium Alloy L160 and the retaining dowels from S99 Steel.

Part Detail	Part Number
Valve Housing	201013715
Retaining Dowels (4 off)	201013714
Torque Link Apex Bolt	201013710
Torque Link Apex Nut	201013675
Bearing Sleeve	201013618
Piston	201013717
Hydraulic Fluid Sample	N/A
Metallic debris found in Turning Tube	N/A

Table 1: Parts Supplied for Examination

CONCLUSIONS

- Damage observed on the valve housing supports the initial conclusions of incorrect assembly causing the over-extension of the landing gear. It is believed that the retaining dowels were assembled in to the orifice slots, rather than the similar sized dowel holes.
- The torque link apex nut threads did not pass the Go-No Go test. Sectioning of the nut revealed an incorrect thread form, explaining the excessive play between the nut and bolt.
- Fluid analysis confirmed that the oil used in the shock absorber was mineral oil with an acceptable water content. Filtration found the presence of mainly aluminium particles, but also some cadmium, iron and copper particles.
- Analysis of the debris found in the turning tube confirmed the presence of aluminium and cadmium particles.

INITIAL EXAMINATION

All components received for examination, excluding the oil sample and metallic debris, are shown in Figure 1. The 4 dowels supplied were in a good condition, other than the usual wear patterns created from in-service use (Figure 2). Analysis of the valve housing revealed some wear to the anodised layer on the OD (Figure 3). A number of scratches were seen near to what was labelled as dowel hole 4 (Figure 4). Circular scratches were found in the orifice slot between dowel holes 1 & 4 (Figure 5). All four orifice slots had a very similar damage pattern on the inner wall of the slot. The typical damage found, two scratches, is shown in Figure 6. Examination of the bearing sleeve showed an uneven wear pattern to the inner diameter. In the location near to dowel hole 4 (Figure 7) the wear was found to be more noticeable than near to dowel hole 2 (Figure 8). Significant play was noted between the apex bolt and nut. Disassembly of the two parts found their threaded regions to be in good condition (Figure 9). The chromium plating on the apex bolt was worn circumferentially in the location of the greasing hole. The piston was also received by the laboratory. This was in a good condition, apart from some wear marks on the inner diameter of the head (Figure 10).

Figure 1: Items received by the M+P laboratory (excluding oil sample)

Figure 2: In-service wear pattern observed on dowels

Figure 3: Wear to the anodised layer of the valve housing

Figure 4: Scratches near dowel hole 4

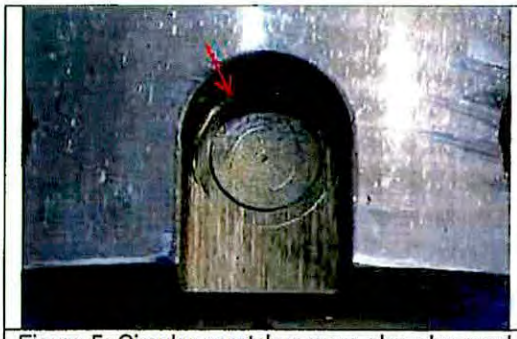

Figure 5: Circular scratches were also observed

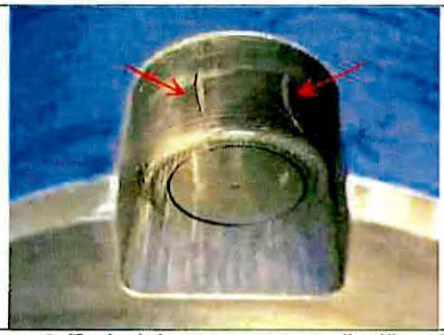

Figure 6: Typical damage seen on all orifice slots

Figure 7: Most wear found on bearing sleeve ID nearest dowel hole 4

Figure 8: Least wear found on bearing sleeve ID nearest dowel hole 2

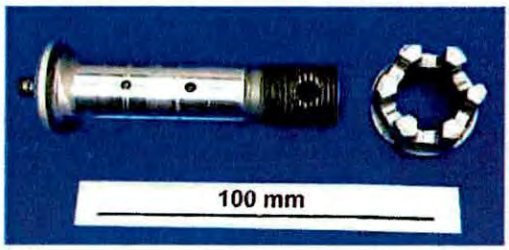

Figure 9: Apex bolt and nut

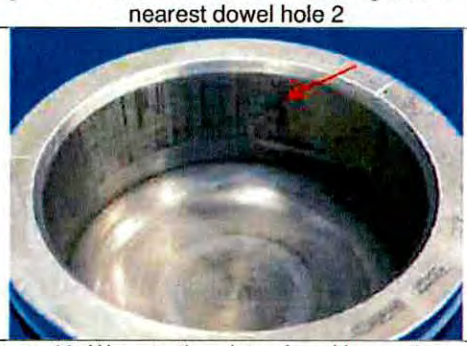

Figure 10: Wear to the piston head inner diameter

DIMENSIONAL MEASUREMENTS

The thread specification for the apex bolt and nut are ¾"-16UNF-2A and ¾"-16UNF-2B respectively. A Go – No Go gauge was used to check the threads on both components. The bolt passed the test but the nut failed. The threaded regions on the Go and No Go ends of the gauge were able to pass through the nut threads, explaining the excessive play between the bolt and nut.

NUT & BOLT EXAMINATION

A microsection was taken through the nut to examine the condition of the threads. The thread profile was not uniform and discontinuities were seen in particularly in the roots of the threads (Figure 11). This was seen on all of the threads on the nut. The microsection was then etched in a 2% Nital solution to reveal its microstructure to check for any grain flow near the roots of the threads (Figure 12). Evidence of grain flow would suggest deformation, but no signs of any grain flow were observed. Microstructural examination confirmed an acceptable tempered martensitic microstructure. Cadmium plating was seen around the thread roots and was in good condition with an average thickness of 11µm (Figures 13 & 14). PCS-2101, which calls up DSS 5353, requires the cadmium thickness on threads to be 5 – 8µm, meaning the plating thickness is slightly above specification. The hardness of the nut was measured and found to be 421 HV 10kg. BS 5S 99 specifies a hardness range of 380 – 435 HV, and therefore is considered acceptable. Binocular examination of the bolt threads revealed them to be in good condition, although in some regions wear of the cadmium was seen (Figure 15).

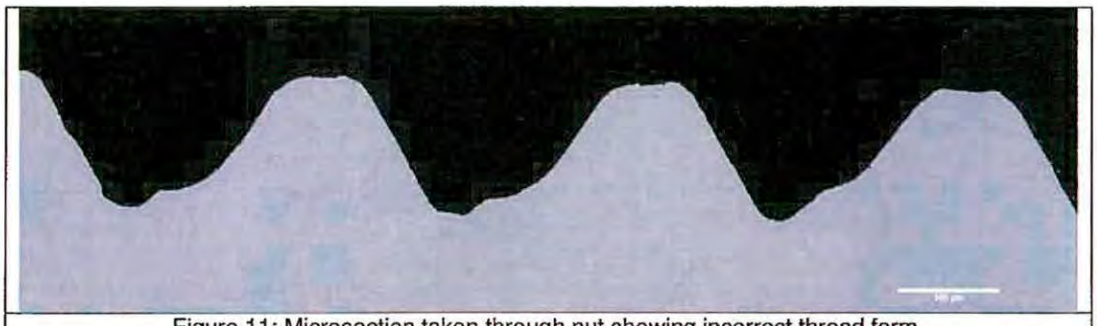

Figure 11: Microsection taken through nut showing incorrect thread form.

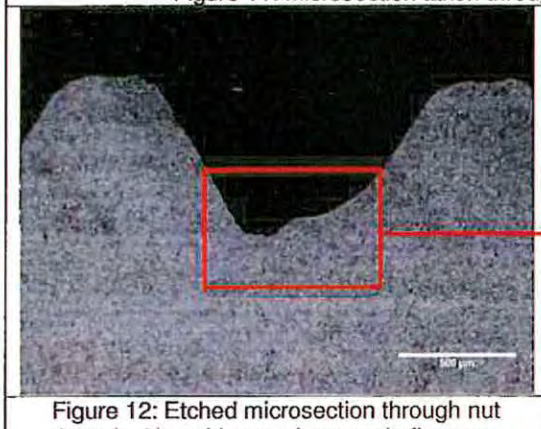

Figure 12: Etched microsection through nut threads. No evidence of any grain flow was observed

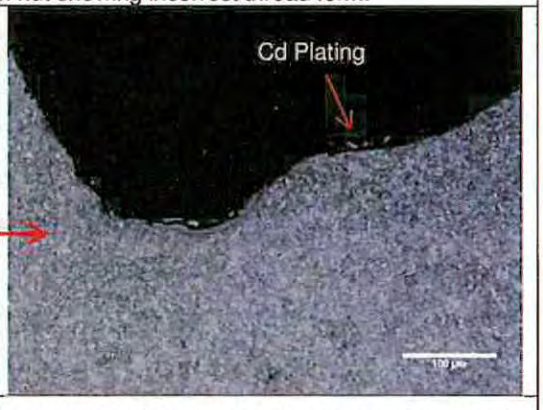

Figure 13: Cadmium plating observed in thread root discontinuity

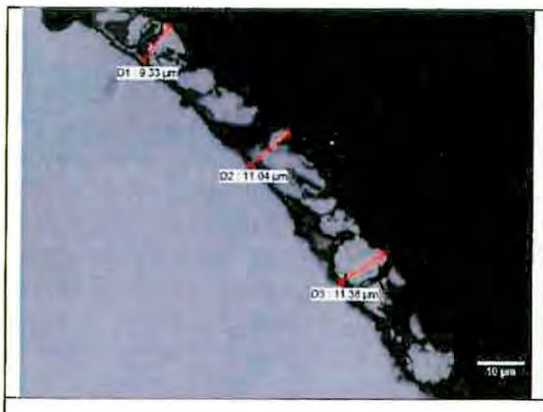

Figure 14: Cadmium plating observed to be an acceptable thickness

Figure 15: Threads on bolt in good condition. The absence of cadmium was observed on the thread flanks and crests. Some regions in the thread roots were also lacking plating

FLUID ANALYSIS

An oil sample obtained from the sliding tube was analysed using FTIR before and after filtration. The two FTIR traces produced did not differ significantly, and confirmed the hydraulic fluid to be a mineral oil in accordance with MIL-5606 (Figure 16). The water content of the oil was also measured and was found to be 41ppm. PCS-7100 states the water content should be <200ppm, and therefore this is considered to be acceptable. A number of metallic particles were observed on the filter paper after the filtration of the oil (Figure 17). SEM-EDX examination was performed on the filter paper to identify the metallic particles. The particles identified were mainly aluminium and cadmium, but some iron and copper particles were also found. The largest particle, which was aluminium, was measured to be 330 µm long (Figure 18).

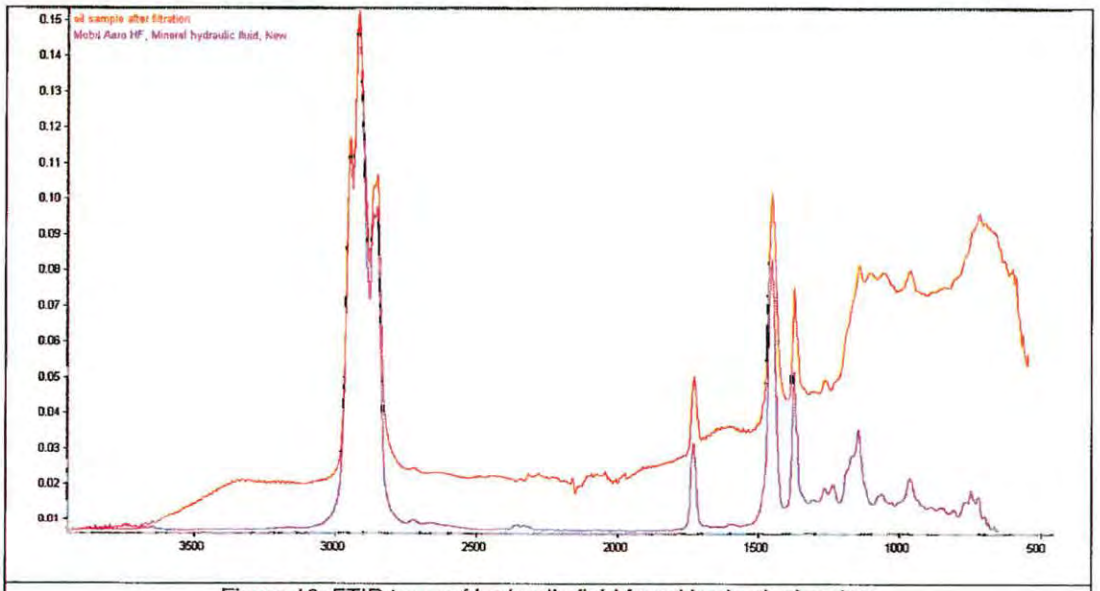

Figure 16: FTIR trace of hydraulic fluid found in shock absorber

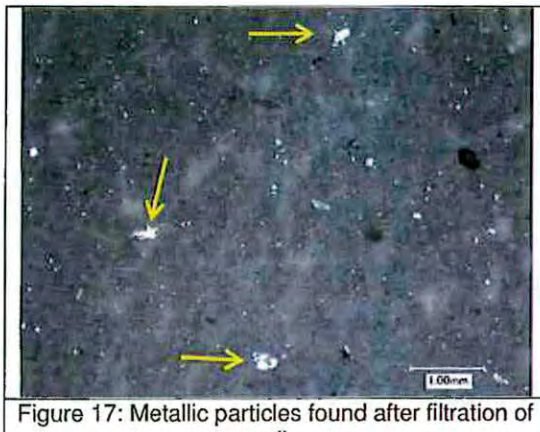

Figure 17: Metallic particles found after filtration of oil

Figure 18: Aluminium particle found on filter paper

DEBRIS ANALYSIS

Some metallic debris which was collected from the turning tube after removal of the slider was also sent for laboratory analysis (Figures 19 & 20). SEM/EDX examination of these metallic particles was used to identify them. The larger block shaped particles, measuring up to 1 mm x 2 mm were aluminium (Figure 21). The long thin shards were an aluminium alloy, with the main alloying element being copper (Figure 22). A number of cadmium particles were also found, measuring up to 500 µm x 250 µm (Figure 23). Table 2 shows a breakdown of the chemical composition of each particle analysed. The valve housing is manufactured form aluminium alloy L160. The metallic debris is not believed to have come from the valve housing, as the compositions do not match (Table 2). The aluminium shard appears to be a 2000 series alloy.

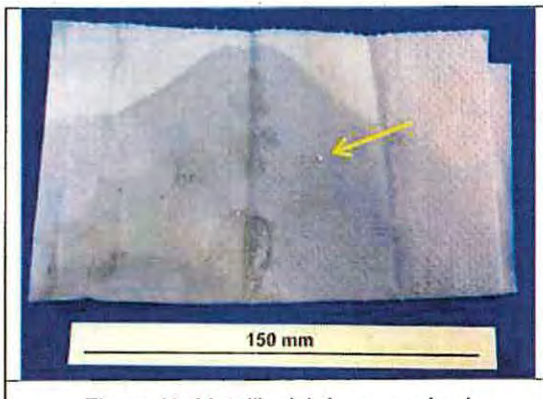

Figure 19: Metallic debris as received

Figure 20: Metallic particles/shards identified to be aluminium

Figure 21: Large aluminium particle

Figure 22: Aluminium shard

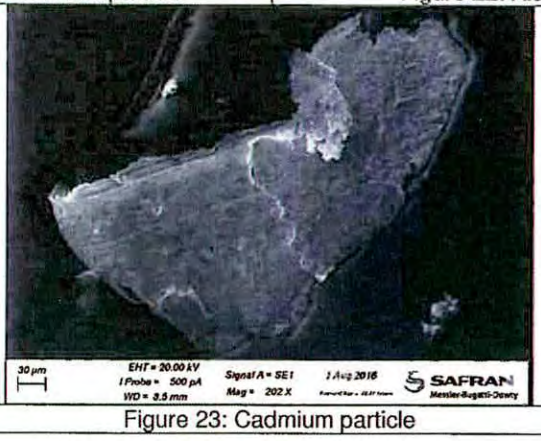

Figure 23: Cadmium particle

	Al	Cd	O	C	Cu	Si	Mn	Mg	Fe	Ti	Zn	Cr
Large Aluminium Particle	98	-	2	-	-	-	-	< 1	-	-	-	-
Aluminium Shard	90	-	5	-	4	< 1	< 1	< 1	-	-	-	-
Cadmium Particle	-	90	4	6	-	-	-	-	-	-	-	-
Al Alloy L160	Bal	-	-	-	1.2 – 2	0.4 Max	0.3 Max	2.1 – 2.9	0.5 Max	0.2 Max	5.1 – 6.1 Max	0.18 – 0.28 Max

Table 2: Chemical Analysis Results (wt. %)

REVISION SHEET

ISSUE	DATE	REVISED	APPROVED	PAGES AFFECTED	REMARKS
1	05/08/16	-	RM/AM	-	Initial Issue
2	25/08/16	PL	RM	1	History updated regarding CSO & CSN.

SAFRAN

TE-GL-00153721 Technical Event Investigation Report

Appendix D

Email Evidence of Tooling Request

(1 Page)

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From:
Sent: 09 June 2016 15:24
To:
Subject: RE: AVAILABILITY

H

Please see price and availability as requested

460005796	Split Ring	1 off
460005797	Spanner Gland seal NLG	1
460005798	Spanner Gland seal NLG	1
460005794	Assembly Post	1

Delivery 90 days from receipt of order
Payment Pro-Forma

Regards

From:
Sent: 01 June 2016 07:17
To:
Subject: AVAILABILITY

Hi

pls check and confirm your sale availability for the following Fokker 50 tools:

p/n 460005796 - SPANNER - NUT AND BEARING ASSY, NOSE LANDING GEAR
p/n 460005797 - SPANNER - OUTSTOP, NOSE LANDING GEAR
p/n 460005798 - SPANNER - NUT AND BEARING ASSY, NOSE LANDING GEAR
p/n 460005794 RING - SEAL INSTALLATION, NOSE LANDING GEAR

Best Regards