30 Apr 2003

From: Customer Liaison Officer
To: Quality Assurance Officer

Subj: FA-18 HYDRAULIC SYSTEM SERVICING

Ref: (a) A1-F18AC-LMM-000
(b) A1-F18AC-PCM-000
(c) A1-F18AC-450-300
(d) A1-F18AC-570-300
(e) Email of 29Apr03 16:48 with Brian Greubel
(f) Air Contamination PPT Brief by FA-18 Hydraulics Project Team

Encl (1) Reservoir Level Gauge Diagram
(2) Air Contamination Monitoring Card

1. Background: During preflight inspection of recent aircraft, I have recognized a few servicing problems/issues and discussed these with Hyd Engineers Brian Greubel, Ralph Zigler, Paul Adoo and ENS John Junek. They concur that the symptoms are evidence of contaminated hydraulic fluid and I would like to pass the following information to the masses in an effort to cease misservicing the fleet's finest aircraft. Ref (a) thru (f) have been reviewed and I have summarized substantive information below.

Air Contamination Basic Theory:

- Free air dissolves into solution with very little pressure (50 psi or greater)
- With system depressurized, air continuously comes out of solution
- Free air is harmful to hydraulic system performance with the following impacts:
    - Known impact:
        - Ingestion of large free air bubble from reservoir into system actuators
        - Pump cavitation (particularly during engine start)
        - May be factor in premature pump degradation
        - Reservoir fluid dumping on engine shutdown
    - Suspected impact:
        - Sluggish FC response
        - Two channel rudder failures
        - Mech reversions
        - Aileron/rudder flutter
- Air contamination detection can positively be identified by the following
    - Reservoir fluid level change before and after first engine start
        - Delta signifies free air content of system and each system can drop no more than the following amount:
            - HS-1 = 1 tick mark
            - HS-2 = 3 tick marks
    - Flight control surface deflection without pressurized system
        - "…if the control surface deflects a few inches or more with not 'too much force' or 'effort', then there is need to do some further inspecting and/or air bleeding of the hyd system" (Ref (5)).
- Reference Encl (1) for amplifying information on reservoir level gauge specifics
- Reference Encl (2) for recommended system monitoring card format

2. The following root cause analysis is provided for the symptoms identified during preflight inspection of aircraft presented for flight and subsequent investigation.

Condition 1: Preflight inspection of hydraulic fluid levels in systems 1 and 2 among different aircraft reveals inconsistent servicing levels among different flight line personnel. A few will fill the system to the green band (proper servicing) while others will fill it until it bleeds (improper).

Direct Cause: Personnel Deficiency- Mindset/preconceived idea. Some believe that the more you fill it up, the better you can avoid a hydraulic loss/emergency. The problem with over filling a system is that "the maintainer believes he is resolving a low hydraulic level after the engine has started by increasing the amount of fluid in the reservoir". (Ref (e)) This is caused by the needle drop after start to a lower value thus the belief that it must be over serviced to end up in the green after start. There is an additional potential to bottom out the piston in the reservoir (occurring when the reservoir is filled to the 5th tick mark in the "full" region) causing fluid to vent overboard (the reservoir has a check valve that opens to ambient when the low pressure side of the reservoir exceeds 140 psig and reseats at 110 psig).

Root Cause: Management/Supervisory Deficiency- Policy not adequately defined/enforced. Ref (b) should be followed WRT proper maintenance action for an overfilled aircraft.

Condition 2: Flight control surfaces can be moved an excessive amount (1 to 2 feet) on preflight inspection with minimal force.

Direct Cause: Material Deficiency- Contaminated material. Air becomes resident in the actuator device which allows the control surface to be easily moved.

Root Cause: Procedural Deficiency- Lack of a procedure. While I have been told that air bleeding occurs in the building 94 process, I cannot find specific reference to the applicable work package (Ref (a)). While there are numerous occasions where the "jenny" is attached to the aircraft, I get different stories depending on which operator I speak with on the floor as to what they are doing and how they are getting the system serviced. I believe that managers feel the system is getting purged by the mere fact that a jenny is getting hooked up and the flight controls actuated; until I see the LMM-000 referenced and stamped off (and should be the last thing they do), I contend that we're not getting it all out on the floor.

Root Cause: Procedural Deficiency- Lack of a procedure. The test line does not currently possess a procedure to determine needle drop on each Hyd system IAW Ref (a) across the board with each of the ASI's but it is in work under the direction of Art Cardone.

Root Cause: Design Deficiency- Inadequate or defective design. There seems to be a manufactured hose out on the test line not currently available in bld 94 which allows servicing of the system without introducing any air.

Root Cause: Management/Supervisory Deficiency- Work organization/planning deficiency. While the belief exists that the systems are getting sufficiently bled, there is no direction to follow Ref (a) and get stamped off either at building 94 or the testline.

Contributing Cause: Procedural Deficiency- Procedure not in compliance. The aircraft are occasionally shut down with the trailing edge flaps in the auto position which induces air into the TEF actuator as gravity works its course and drops the TEF which sucks air past the TEF seal.

Condition 3: 997/998 MSP codes that often occur particular to an aircraft (most often a 998 code).

Direct Cause: 997 (Hyd 1 low) and 998 (Hyd 2 low) are the result of a mechanical interface that pops the code whenever the needle on the gauge dips below the Refill line less 4 degrees (slightly less than 1 tick mark which is 5.25 degrees).

Root Cause: Management Supervisory Deficiency- Work organization/planning deficiency. Building 94 artisans must be responsible for adjusting the gauges when the system is bled.

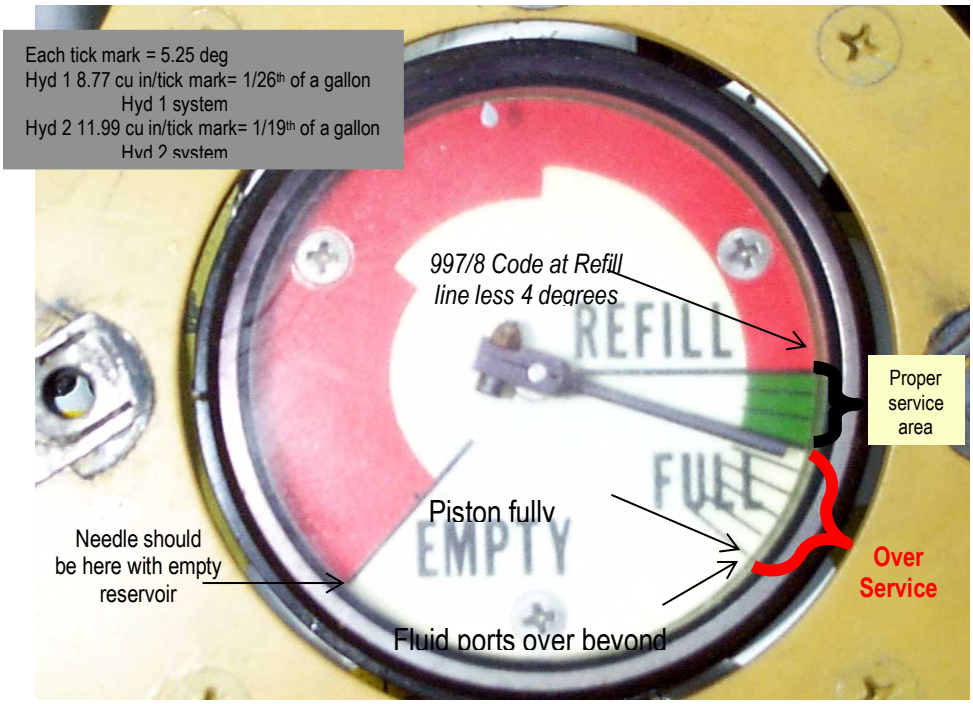
Contributing Cause: Equipment/Tool Deficiency- Calibration expired/inaccurate. A walk through building 94 will show many of the hydraulic gages on empty aircraft hydraulic systems showing many different positions other than an angle coincident with “Empty” on the gage. This is verified by test line personnel adjusting the needles themselves on systems they have to drain for any unscheduled maintenance. If the system gets “over serviced” as a result of an inaccurate needle but the needle shows it “in the green”, then the excess fluid will get vented overboard thus dropping the needle in the red and a vicious cycle of chasing the needle follows.

Contributing Cause: Material Deficiency- Contaminated material. Reference the above discussion on air in the system. Excessive air will show a properly serviced system until start-up and potentially dip the needle “in the red” causing the 997/998 codes.

V/R

J. Fernandez

Reservoir Level Gauge



Encl (1)

180	190	**200**	210	220	230
☐	☐	☐	☐	☐	☐

RECORD TEMP BEFORE START

180	190	**200**	210	220	230
☐	☐	☐	☐	☐	☐

A/C _____ Julian Date _____ Time _____

Pre-Flight Servicing by _____

_____

(L) HS-1 (R) HS-2

BEFORE START

AFTER START

AFTER FLIGHT

Did HS-1 (PORT) dump fluid upon engine shutdown? YES NO
Did HS-2 (STBD) dump fluid upon engine shutdown? YES NO

NOTES: _____

FUEL LOAD AT SHUT DOWN _____

Fuel at or below 1600 Lbs at Shut Down? _____

Fuel at or below 2400Lbs during Hot Seat refuel ? _____

180	190	**200**	210	220	230
☐	☐	☐	☐	☐	☐

RECORD TEMP AFTER SHUT DOWN

180	190	**200**	210	220	230
☐	☐	☐	☐	☐	☐

F/A-18 MMP/MSP Codes

MMP/MSP CODES	
BEFORE FLIGHT	AFTER FLIGHT

NDW-NAWCAD 13020/1 (REV. 9-97)

Encl (2)