WEC INSTRUMENT USER MANUAL

CHAPTER 5

COMMISSIONING

Table of Contents

Acronyms

See Chapter 1.

5.1 Introduction

The WEC supports the concept discussed at the operation meeting in ESA on 15/16 Feb. 1994. This distinguishes between:

- Commissioning phase
- Interference phase
- Inter-calibration phase

These are discussed in the following sections.

The detailed procedures which are described in this chapter concern one spacecraft. The same procedures are to be used on each of the four spacecraft.

5.2 COMMISSIONING OVERVIEW

WEC equipment commissioning is strongly linked to the wire boom deployment (see section 5.2 for a full description of the deployment procedure). In what follows, several major assumptions are made:

(1) After the last boom deployment manoeuvre, there will be an EMC-EMI session where all the equipment already switched ON will be switched OFF in such a way that each WEC instrument may listen to the switching ON of the other WEC instruments.

(2) During the deployment period, where power is needed for the motor, FGM, DWP and EFW are the only experiments which are ON.

(3) The same tests will be performed on each satellites.

(4) It is also required that wave diagnostics periods are scheduled to allow simultaneous measurements on 2 sc whenever possible. This should allow comparisons at the same length and at different lengths of different phases of deployement.

5.2.1 EFW purposes

EFW wishes to make measurements as the booms are deployed, to gather diagnostic information useful for the interpretation of the electric field and density measurements to be made later in the mission. It is necessary that DWP and FGM be on. It is also of interest to compare measurements with other experiments, if they are on, but this can also be done later, when the booms are fully deployed. The essential measurements are those at DC and low frequencies.

The measurements to be made by EFW during commissioning phase are:

1. Basic tests that the instrument is operational:

- Calibration sequence on each probe.
- Verify that each probe can measure in E-field mode and density mode.
- Verify that all telemetry modes are functioning.
- Verify that all commands are accepted by the instrument.
- Verify the functionality of sweeps, including all adjustable parameters.
- Verify the functionality of on-board spin fits.
- Verify all possible signals from instrument (different filters etc).
- Verify "burst" trigger, storage in memory and dump of memory.

2. Tests of the instrument operation in different plasma environments.

- Electric field measurements, using different values for bias current, guard voltage and puck voltage.
- Probe current measurements, using different probe voltage bias.
- Current sweeps at different sun angles.
- Voltage sweeps at different sun angles.

Useful background information:

- The boom deployment speed is 1 cm/s.
- The bias current may be varied between -500 nA and +500 nA in 256 steps (approx 4 nA/step).
- The guard voltage may be varied between -39 V and +39 V in 256 steps (approx 0.3 V/step).
- The puck voltage may be varied between -1.26 V and +1.26 V in 256 steps (approx 0.01 V/step).
- The probe voltage may be varied between -30 V and +30 V in 256 steps (approx 0.235 V/step).
- Minimum step duration: 1/150 s (6.67 ms)
- Maximum step duration: 255/150 s (1700 ms)
- Minimum sweep interval: 32 s (0.53 min)

- Maximum sweep interval: 255*32 s (136 min)
- Sweeps are performed on V12 and V34 alternately. Thus the interval between, e.g., V12 sweeps, is between 64 s and 272 min.

5.2.2 STAFF purposes

During the commissioning phase STAFF wants first to verify that the instrument works correctly, that the different modes of operation work, by means in particular of the calibration program. The calibration should run with and without despin, in order to make comparison with ground data. Passive measurements (no calibration) should be made at the different phases of the EFW boom deployment, as STAFF SA makes E wave measurements, and this will be a unique opportunity, from both technical and scientific points of view. In order to choose the best operational modes, it is necessary to evaluate all possible interferences due to other WEC instruments. That is why full (NM1) STAFF SA modes should work during all Whisper and EFW modes (including density modes), as far as it is compatible with the overall WEC strategy. For the same reason of choosing the best operational modes, STAFF desires that all WEC modes be tested once all 4 booms are completely deployed. Some tests can only be done in burst mode, the calibration of the 180 Hz filter in particular, then some operation time in burst mode is requested. After the end of boom deployment, some test of STAFF SA software patch are also requested.

At the first verification phase, or start up (A4) STAFF wants that both power line be tested (normal and redundant), verify that the power consumption is correct, and also that the instruments work by looking at the "scientific" housekeeping parameters, the STAFF SC Bmax-min and the STAFF SA AGC. The Bmax-min show whether the search coil chain works or not, indicating the presence of the spin signal on Bymax-min and Bzmax-min and not on Bxmax-min. The variability of the STAFF SA AGC gives evidence that the instrument works.

5.2.3 WHISPER purposes

The measurements to be made by WHISPER during the commissioning phase are:

1. Initial health test of the Whisper module proper. Real time.

- Verify the functioning of the receiver and spectral analysis (quiet calibration)
- Verify the content of the on-board memory

2. Basic diagnostics after each deployment phase. Real time.

- Verify the functioning of the receiver and spectral analysis (quiet calibration)
- Verify the functioning of the on-board synthetizer, and the connection to the transmitting antennas (sounding calibration)
- Verify the integrity of the complete chain, including EFW sensors (Natural mode, Whisper processing)
- Check the DWP on board data compression (Natural mode, DWP processing)
- Verify the detailed functioning of the sounder: listening of the electric signal in the full bandwidth after a pulse transmission (Sounding 'transparent' mode)
- Verify the standard functioning of the sounder (Sounding modes, DWP processing)

3. WEC diagnostics at different antenna lengths: basic instrument operations for a range of tuning options. Non real time.

- Natural noise measurements using standard values of FFT size, gains, number of accumulated spectra.
- Sounder operations with different values of transmitter level, gain, pulse duration, and step duration.
- Use of WBD to survey the signal received by the double sphere dipole of the transmitting booms (while WHISPER analyses the signal recorded by the other pair).

4. First full WHISPER tests: toward the optimization of sounder operations and natural noise measurements. Non real time.

In NM telemetry:

- Test SYNC mode A with several sounding tables and transmission levels
- Test Continuous sounding with different options of the combination of sounding tables, step durations, compression strategy options
- Test Natural modes with different options of FFT size, spectra accumulation, compression strategy, especially those combinations fitted for WEC NBR basic mode

In BM telemetry:

- Test Gliding mode with several sounding tables and transmission levels
- Test Natural modes for fine directivity measurements
- Test Natural mode options fitted for WEC HBR basic mode

- Test HBR continuous mode

5. Interference tests inside WEC. Non real time.

- Test the sounding options selected after first full WHISPER tests, to probe the level of pollution toward other WEC instruments. Operations in both NBR and HBR telemetry have to be checked.

5.2.4 WBD purposes

During the commissioning phase the aim of the Wideband Data instrument is to verify that the instrument can be commanded correctly and that data can be routed correctly either through the DWP instrument or the DSN. Tests will also be made to check the interference levels from other instruments.

5.2.5 DWP purposes

At the start of the commissioning phase the objective of the DWP team is to check that the basic configurations of DWP are functioning and that the kernel can be allocated and run on all processors. It is also proposed that the initial POWER ON state be verified and that the WATCH DOG circuit be tested by deliberately corrupting the checksummed memory. The tests will be carried out using both the spacecraft nominal and redundant interfaces (power, telemetry and telecommand). DWP will then check the integrity of the kernel code by using the memory dump facility.
It is proposed that a comprehensive checkout of the interfaces with the WEC instruments, the applications software and much of the kernel software will be made during the commissioning of the rest of the WEC instruments. The checkout of the correlator will be performed after the commissioning of the PEACE instrument and the IEL.

5.2.6 Power Supply purposes

The objective at the start of the commissioning phase is to verify the integrity of the WEC power supply by checking that it is powered on correctly by the spacecraft supply and that it supplies the correct voltage to the DWP instrument. The rest of the WEC instruments will then be switched on in sequence to verify that the relays operate correctly and that the correct voltage and current is supplied to each instument.

5.2.7 Overview of Sequences

The WEC commissioning plan is strongly linked to the steps of the boom deployments.

A Startup (6h)

Step	ESOC procedure	Description
A.1		FGM on
A.2	FCP_WEC_C001	DWP on (30 min realtime)
A.4	FCP_WEC_C003	First full WEC on (60 min realtime)
A.3	FCP_WEC_C002	DWP checkout (120 min non realtime)
A.5	FCP_WEC_C004	Power on DWP and EFW only (10 min realtime)
A.6	FCP_WEC_C005	EFW 1st verification (15 min realtime)
A.7		Pause 2h (to verify EFW operations)
A.8	As A6 (TBC by A7)	EFW 2nd verification (15 min realtime)

B First deployment (4h realtime + 1 orbit)

Spin rate: 15 -> 22 rpm
L: 0+0 -> 15+15 m

Step	ESOC procedure	Description
B.0		S/C manoeuvre:Spin up to 15 rpm
B.1	FCP_WEC_C017	Test: DWP and EFW on
B.2	FCP_WEC_C007	Cover releases pyro fired (real time)
B.3	FCP_WEC_C008	Deployment booms 3+4 (40 min realtime) Deploy booms 3&4 from 1.3 m to 15.0 m Spin decreases from 15 rpm to 13.22(*) rpm.
B.4	FCP_WEC_C009	Deployment booms 1+2 (40 min realtime) Deploy booms 1&2 from 1.3 m to 20.0 m Spin decreases from 13.22 (*) rpm to 11.82 (*) rpm
B.5		S/C manoeuvre: Spin-up to 22 rpm (150 seconds), unwinding of 1.5m thin wire inside EFW spherical sensor

B.6	FCP_WEC_CA15 FCP_WEC_CY11	EFW diagnostics (30 min realtime)
B.7	FCP_WEC_CA12 FCP_WEC_C020	WHISPER diagnostics (45 min realtime)
B.8	FCP_WEC_C013	STAFF diagnostics (30 min realtime)
B.9	FCP_WEC_C014 or FCP_WEC_C016	WBD BM2 diagnostics (15 min non-realtime), or DSN if available (30 mins realtime).
B.10.1	FCP_WEC_CA15 FCP_WEC_CB15	WEC diagnostics (4 x 3 h non realtime during 1 orbit) + DSN if available.
B.10.2	FCP_WEC_CB15	
B.10.3	FCP_WEC_CB15	
B.10.4	FCP_WEC_CB15 FCP_WEC_CC15	
B.11	As B9	WBD BM2 diagnostics (15 min non-realtime) if not run in B.9, or DSN if available, or none.

After B.6, EFW wishes to be switched ON continuously.

C Second deployment (2h realtime + 1 orbit)

Spin rate: 22 -> 13.52 rpm
L: 15+15 -> 35+20 m

Step	**ESOC procedure**	**Description**
C.1	FCP_WEC_C017	WEC status: DWP and EFW on; STAFF, WHISPER , WBD Off
C.2	FCP_WEC_C018	Deployment booms 3+4 (30 min realtime) Deploy booms 3&4 from 15 to 35 meters Spin decreases from 22 to 14.27 (*) rpm.

C.3	FCP_WEC_C019	Deployment booms 1+2 (30 min realtime) Deploy booms 1&2 from 15 to 20 meters Spin decreases from 14.27 to 13.52 (*) rpm.
C.4	As B6	EFW diagnostics (30 min realtime)
C.5	FCP_WEC_C020	WHISPER Diagnostics (30 min real time)
C.6	As B8	STAFF diagnostics (30 min realtime)
C.7	As B10	WEC diagnostics (4 x 3 h non realtime during 1 orbit)
C.8	As B9	WBD diagnostics (30 min max)

D Third deployment (2h realtime + 3 orbits)

Spin rate: 13.52 -> 15 rpm
L: 35+20 -> 42+20 m

Step	**ESOC procedure**	**Description**
D.0		S/C manoeuvre: Spin-up to 17 rpm
D.1	FCP_WEC_C017	WEC status: DWP and EFW on
D.2	FCP_WEC_C023	Deployment booms 3+4 (30 min realtime) Deploy booms 3&4 from 35 to 42 meters Spin decreases from 17 rpm to 14.13 (*) rpm.
D.3		S/C manoeuvre: Spin-up to 15 rpm (TBD min realtime)
D.4	As B6	EFW diagnostics (30 min realtime)
D.5	As C5	WHISPER diagnostics (30 min realtime)
D.6	FCP_WEC_C032	STAFF diagnostics (30 min realtime)
D.7	As B10	WEC diagnostics (4 x 3 h non realtime during 1 orbit) + DSN if available
D.8	As B9	WBD diagnostics (30 min max)
D.9	As B10	WEC diagnostics (4 x 3 h non realtime during 1 orbit) + DSN if available
D.10	As B9	WBD diagnostics (30 min max)
D.11	As B10	WEC diagnostics (4 x 3 h non realtime during 1 orbit) +

		DSN if available
D.12	As B9	WBD diagnostics (30 min max)

E Fourth deployment (2h realtime + 2 orbits)

Spin rate: 15 -> 15 rpm
L: 42+20 -> 42+42 m

Step	**ESOC procedure**	**Description**
E.1	FCP_WEC_C017	WEC status: DWP and EFW on (STAFF, WHISPER, WBD Off)
E.2	FCP_WEC_C026	Deployment booms 1+2 (30 min realtime) Deploy booms 1&2 from 20 to 42 meters Spin decreases from 15 rpm to 10.7 (*) rpm
E.3		S/C manoeuvre: Spin-up to 15 rpm (TBD min realtime)
E.4	As B6	EFW diagnostics (30 min realtime)
E.5	As C5	WHISPER diagnostics (30 min realtime)
E.6	As B8	STAFF diagnostics (30 min real time)
E.7	As B10	WEC diagnostics (4x 3 h non realtime during 1 orbit) + DSN if available
E.8	As B9	WBD diagnostics (30 min max)
E.9	FCP_WEC_C028 FCP_WEC_C029 FCP_WEC_C030 FCP_WEC_C031	WEC HBR diagnostics (4x 30 min non real time dur. 1 orb.)
E.10	As B9	WBD diagnostics (30 min max)

After E.6, STAFF and WHISPER wish to stay ON continuously.

F Other tests

Step	**ESOC procedure**	**Description**

F.1	FCP_WEC_C033	Full EFW tests (2 hours non real time)
F.2	FCP_WEC_C034	Full WHISPER tests (2 hours non real time)
F.3	FCP_WEC_C035	Full STAFF tests (1 hour non real time)
F.4	TBD	Full WBD tests (1 hour non real time)
F.5	FCP_WEC_C036	Full WEC macro tests in NBR (1 hour non real time)
F.6	FCP_WEC_C037 FCP_WEC_C046	Full WEC macro test in HBR (1 hour non real time)
F.7	FCP_WEC_C047	Interference tests inside WEC (BM2)
F.8	FCP_WEC_C048	Interference tests within WEC (DSN)

(*) These spin rates and spin-up durations are not official, but computed by P-A Lindqvist.

G IEL tests

G.2	FCP_WEC_C049	PEACE/DWP correlator test.

Details on each step are given in section 5.2.

5.3 [PRIVATE] COMMISSIONING DETAILED WEC SEQUENCES

A. STARTUP

WEC request is that all the other experiments are OFF except FGM during the phase A.

A.1 *FGM on*

It is assumed that FGM will be turned ON and tested the first (attitude control).

A.2 *DWP on*

1 Introduction

1.1 Test conditions

This test is defined for the first WEC in flight power on. Real time telemetry is required, with real time verification of the HK parameters listed in Annex A.2 section 1.3. In the event that any parameter goes out of limits the WEC shall be turned off using the command sequence in Annex A.2 section 1.4. Additional parameters may be verified off-line after the test.

The OBDH should be in normal mode and the sun-reference pulse working. If the latter will not be at its nominal 4 second period when the test is run, WEC should be informed of this.

There are no requirements for any other experiment to be on or off when this test is run, although the WEC team should be informed whether PEACE and FGM are on or off as this will effect the value of some parameters to be checked off-line.

1.2 Overview of test

The test is conducted in two parts, firstly using the nominal spacecraft interfaces (power, telemetry and telecommand) and secondly using the redundant interfaces. Each part consists of a very similar command sequence. Each part starts with WEC power on (PWR and DWP), followed by a single

command to prevent power on of any other WEC instruments. Following verification of the initial power on state, the Watch Dog circuit is tested by deliberately corrupting the DWP checksummed memory. DWP is then switched to the minimum useful power configuration of one processor at half speed and the kernel process allocated to two processors in turn. Finally DWP is switched to the maximum power configuration that is possible without activating any other WEC instruments, that is three processors at full speed with correlator active. The kernel is allocated to each processor in turn. Note that there is no requirement for PEACE to be on - the correlator is simply being used to load the processors and it can do this with no input.

The full procedure is provided in the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. The ESOC procedure is FCP_WEC_C001.

The same test is performed with the redundant interfaces using ESOC procedure FCPBWEC_C001. It is also necessary to run an appropriate OBDH procedure to select the redundant interfaces on the spacecraft side.

A.3 *DWP check out*

1 Introduction

1.1 Test conditions

This test is defined for use after the first limited WEC turn on (PWR and DWP only), but before any of the other WEC instruments have been powered on. The test is required to run without real time telemetry. As it is preferable that the other WEC instruments do not power up unexpectedly, the WEC current should be monitored by the OBDH, and the WEC be switched off if the current exceeds a set limit (100 mA, TBC). As such monitoring is not easily possible it has been decided to pospone this test until after the first full WEC power on in step A4.

The test was required to run for about 120 minutes and produce 333k bytes of data. This can be achieved by running in normal mode for 100 seconds and housekeeping only for the rest of the test. However it is now proposed to run in normal science mode for the whole of the test, so the quantity of data produced will be considerably larger.

1.2 Overview of test

This test is intended as a comprehesive checkout of DWP without using any of the other WEC instruments. This is somewhat of a contradiction, as it is clearly not possible to test any of the WEC instrument interfaces under these conditions, and it is also not possible to test most of the applications software and much of the kernel software. All the basic configurations of DWP (half speed, full speed, kernel on different processors, nominal and redundant S/C interfaces) will have been tested during step A2. The integrity of the kernel code can be verified using the kernel memory dump facility (address 0x04D8 to 0x28FE), which will take about 53 minutes of HK telemetry. The 120 minute duration of the test is sufficient for two processors to be dumped. Software provided by the DWP team will be used to compare the memory dumps with a reference version.

The full command sequence is provided in the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C002.

A.4 *First full WEC ON*

The first full WEC turn On shall be made on line with observation of a limited number of HK parameters by using a pre-defined procedure (see A.2). and in the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. The ESOC procedure is FCP_WEC_C003.

All WEC instruments are turned on step by step with a verification of a list of parameters.

The full procedure is provided in Annex A.4 of Chapter 5. and in the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual.

A.5 *Test*

WEC power on DWP and EFW only. STAFF, WHISPER, and WBD OFF ; verifications as explained in Annex A.4. . The ESOC procedure is FCP_WEC_C004.

A.6 *EFW 1st verification* (15 minutes real time)

EFW special verification to test and check the EFW ability to understand and to manage the commands re-transmitted by DWP. It is also to check that EFW is capable of handling the commands to deploy the booms. A summary of the procedure can be as follows:

- DWP and EFW only ON
- Run a small EFW test.
- EFW commands.

The full procedure is provided in the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C005.

Verification procedure for A.6 and A.8.

This test is functionally identical to the WEC level AFT, An EFW test scanner (ets) has been developed and used in the last three years. It will take as input the WEC housekeeping and science files and generates a test report.

A.7 *EFW diagnostic*

Off line verification of the recorded data (2 h).

A.8 *EFW 2nd verification* (15 minutes real time)

Identical to A.6 if A.7 OK

- EFW commands.

. - if all successful the deployment can be envisaged.

B. FIRST DEPLOYMENT

WEC requests that all the other experiments are OFF except FGM from B.0 to B.9, for B.10 and B.11 it is TBD.

B.0 *S/C manoeuvre*

Spin up to 17 rpm (10 minutes real time)

T+0 min:

. Start spin up at (TBD) rpm

T+(TBD) min:

. Stop spin up at 17 rpm

B.1 *Test*

Only DWP and EFW are ON. A real time tm is required.

B.2 *S/C manoeuvre*

cover release

T+0 min:

. Fire pyros to release covers 3 and 4

. Fire pyros to release covers 1 and 2

. The ESOC procedure is FCP_WEC_C007.

B.3. *Boom deployment* 3+4

During 1st boom deployment 3 &4 1.3 - 20 m (40 mn realtime):

T+0 min:

. Set probes (1234) in mode (DDDD)

. Set optimum Vbias 0 V on all probes

. Set optimum Vguard -0 V

. Set optimum Vpuck 0 V

. No sweeps

. Start deployment booms 3+4 at 1.3 m, 17 rpm

T+xxx sec:

. Stop deployment booms 3+4 at 4.3 m.

. Set probes (1234) in mode (EEEE)

. Set optimum Ibias -40.0(TBC) nA on all probes

. Set optimum Vguard -3(TBC) V

. Set optimum Vpuck 0(TBC) V

. No sweeps

. Start deployment booms 3+4 at 4.3 m.

T+ ~ 31 minutes 10 seconds

. Stop deployment booms 3+4 at 20 m, 13.6(TBC) rpm

The full procedure is provided in EFW_COMMISS_B3 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C008.

B.4 *Boom deployment* 1+2

Second deployment 1 &2 1.3 - 20 m (40 mn realtime)

If no other instructions are given, the mode is to be the following.

T+0 min:

. Set probes (1234) in mode (DDDD)

. Set optimum Vbias 0 V on all probes

. Set optimum Vguard -0 V

. Set optimum Vpuck 0 V

. No sweeps

. Start deployment booms 3+4 at 1.3 m, 17 rpm

T+xxx min:

. Stop deployment booms 3+4 at 4.3 m.

T+xxx min:

. Set probes (1234) in mode (EEEE)

. Set optimum Ibias -40(TBC) nA on all probes

. Set optimum Vguard -3(TBC) V

. Set optimum Vpuck 0(TBC) V

. No sweeps

. Start deployment booms 1+2 at 4.3 m, 13.6(TBC) rpm

T+ ~ 31 min 10 sec:

. Stop deployment booms 1+2 at 20 m, 11.3(TBC) rpm

The full procedure is provided in EFW_COMMISS_B4 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C009.

B.5 *S/C manoeuvre*

Spin from 11.3 up to 22 rpm and unwinding of thin wire (10 minute realtime) - Verification

T+0 min:

. Start spin up at 11.3(TBC) rpm

T+150(TBC) sec

. Stop spin up at 22 rpm

. Check that thin wires unwound (How?)

B.6 *EFW diagnostics* (30 min realtime)

After 1st boom deployment and top hat release :

T+0 min:

. Set probes (1234) in mode (EEDD)

. Set optimum Ibias -40(TBC) nA on probes 1+2

. Set optimum Vbias +5(TBC) V on probes 3+4

. Perform a fast current sweep and a fast voltage sweep on probes 1+2

once every 2 spins, stepping

Vguard = {-10, -5, 0, +5} V (values TBC)

Vpuck = {-1, 0, +1} V (values TBC)

Sweep sun angle = {0, 90, 180, 270} degrees

Sweep parameters are:

21 current values between +100 nA and -300 nA (values TBC)

21 voltage values between +20 V and -20 V (values TBC)

20(TBC) ms at each current/voltage step

T+7 min:

. Keep probes (1234) in mode (EEDD)

. Perform fast sweeps as above, but on probes 3+4

T+14 min:

. Set probes (1234) in mode (DDEE)

. Set optimum Ibias -40(TBC) nA on probes 3+4

. Set optimum Vbias +5(TBC) V on probes 1+2

. Perform fast sweeps as above, but on probes 1+2

T+21 min:

. Keep probes (1234) in mode (DDEE)

. Perform fast sweeps as above, but on probes 3+4

T+28 min:

. Set probes (1234) in mode (EEEE)

. Set optimum Ibias -40(TBC) nA on all probes

. Set optimum Vguard -3(TBC) V

. Set optimum Vpuck 0(TBC) V

. No sweeps

T+30 min:

[end of 30 min EFW diagnostics]

The full procedure is provided in EFW_COMMISS_B6 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedures are FCP_WEC_CA15 and FCP_WEC_CY11.

B.7 *WHISPER diagnostics*

WHISPER is turned on for a memory dump and a calibration. A real time tm is required.

The total duration is of the order of 45 minutes. As a large amount of telemetry is requested for WHISPER during this test, STAFF S/C and SA must remain OFF.

- Whisper power On if necessary -

B7.a

STEP 0	Memory dump	WCMW E0080(5)00	12 min 45 s

B7.b

STEP 1	a) Quiet calibration: long:	WCMW D0000000	2 min 45 s

	short:	WCMW D0080000	5s
	b) Passive survey: Whisper processing: (8 spectra, 8 accumulations, 256 bins, Ez, 3613bps)	WCMW C9386000	10 s
	c) idem Ey	WCMW C9386800	10 s
STEP 2	a) TX power on	C245	15 s
	b) Sounding calibration: long:	WCMW B0000000	2 min 45 s
	short:	WCMW B0080000	5 s
STEP 3	a)Passive reference, Natural waves (8 spectra, 64 accumulations, 512 bins, auto 24/36dB gain, Ez, 8bpw, select rate: All, 4614bps)	WCMW CD6060xx WPW08	10 s
	b) Sounding operations, Whisper transparent, short sweep, auto 12/24dB gain, high level, 1sweep, 21 emissions/sweep, 630 bps, normal sampling	WCMW AC0B504D,	4 min 35 s
	c) idem, medium sampling	WCMW AC0A504D	4 min 35 s
	d) Passive reference,	WCMW CD6060xx WPW08	10 s
	e) Sounding, Whisper processing, 2 levels, auto 12/24dB gain, 2 sweeps/level, 2003bps, delayed sampling		
	Medium Level	WCMW AD0E500C	8 s
	High Level	WCMW AD0F500C	8 s
	f) Passive reference,	WCMW CD6060xx WPW08	10 s
	g) Sounding, Whisper processing, 2 levels, auto 12/24dB gain, 2 sweeps/level, 2003bps, normal sampling:		
	Medium level	WCMW AD0A500B	12 s

	High level	WCMW AD0B500B	12 s
STEP 4	a) Passive reference,	WCMW CD6060xx WPW08	10 s
	b) Sounding, standard, DWP processing, 3 levels, 4 gains, Ez (32 sweeps, 1E 2R mixed table complete frequency range, strategy B, reduced passive information, 8bpw adjusted, 3791bps), normal sampling		
	B1) Low level, auto 36/24dB gain	WCMW AE11600E WPW08	50 s
	B2) Passive reference	WCMW CD6060xx WPW08	10s
	B3) Medium level, auto 36/24dB gain	WCMW AE12600E WPW08	50 s
	B4) Passive reference	WCMW CD6060xx WPW08	10s
	B5) Medium level, auto 24/12dB gain	WCMW AE12500E WPW08	50 s
	B6) Passive reference	WCMW CD6060xx WPW08	10s
	B7) High level, auto 24/12dB gain	WCMW AE13500E WPW08	50 s
	c) Passive reference	WCMW CD6060xx WPW08	10s
STEP 5	a) Passive reference, Ey	WCMW CD6068xx WPW08	10s
	b) Sounding, standard, DWP processing, 3 levels, 4 gains, Ey (32 sweeps, 1E 3R mixed table complete frequency range, strategy B, reduced passive information, 8bpw adjusted, 3791bps), delayed sampling		
	B1) Low level, auto 36/24dB gain	WCMW AE25680E WPW08	70 s
	B2) Passive reference, Ey	WCMW CD6068xx WPW08	10s
	B3) Medium level, auto 36/24dB gain	WCMW AE26680E WPW08	70 s
	B4) Passive reference, Ey	WCMW CD6068xx WPW08	10s
	B5) Medium level, auto 24/12dB gain	WCMW AE26580E WPW08	70s

	B6) Passive reference, Ey	WCMW CD6068x WPW08	10s
	B7) High level, auto 24/12in	WCMW AE27580E WPW08	70 s

Test duration about 39 min, not including interstep pauses, for B.7

The full procedure is provided in WHI_COMMISS_B7.a and WHI_COMMISS_B7.b of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedures are FCP_WEC_CA12 and FCP_WEC_C020.

B.8 *STAFF diagnostics*

STAFF is turned on for internal checks. Real time is required. The duration is about 30 minutes. Both passive measurements and calibration are performed, for full experiment verification.

Time (minutes)	Mode
00	STAFF SC =EM (no compression)
	STAFF SA =NM1 (with despin ON)
05	DESPIN OFF
10	CAL ON
17	DESPIN ON
	STAFF SC=NM (normal compression)
	CAL ON
24	STAFF SA=NM1
30	end of STAFF sequence

The full procedure is provided in STA_COMMISS_B8 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C013.

B.9 *WBD diagnostics*

This procedure tests the Wideband Data instrument in auto gain 8 bits with various bandwidths at baseband and with frequency conversion. The data path is via DWP. A short test of the digital filtering in DWP is also included.

Depending on the availability of the DSN, diagnostics using DSN may be run.

The full procedure is provided in WBD_COMMISS_B9 or WBD_COMMISS_DSN of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C014 (BM2) or FCP_WEC_C016 (DSN).

B.10 *WEC diagnostics* (4 x 3 h non realtime during 1 orbit)

All WEC during 1 orbit.

Wave diagnostic on several plasma regions such as: solar wind, far magnetosphere, close magnetosphere, etc.

Maximum number of regions to be investigated: 4.

Duration of each diagnostic 3 hours (all together a maximum of 12 hours).

No real time tm is required. No constraint on further operations while waiting to analyse the diagnostics.

T+0 min:

. EFW Set probes (1234) in mode (EEEE)

. EFW Set optimum Ibias -40(TBC) nA on probes 3+4

STAFF ON mode NM1, DESPIN ON

WHISPER natural mode N1 (see Annex B.10 of Chapter 5)

WBD ON.

. EFW Perform slow current sweep on probes 1+2 once every 2 spins, stepping

Vguard = {-10, -5, 0, +5} V (values TBC)

Vpuck = {-1, -0.5, 0, +0.5} V (values TBC)

Ibias = {+60, 0, -60, -120, -180, -240, -300} nA (values TBC)

Sweep parameters are defined by the above settings:

4 guard values between -10 V and +5 V (values TBC)

4 puck values between -1 V and +0.5 V (values TBC)

7 current values between +60 nA and -300 nA (values TBC)

2 spins at each current step

Run WHISPER N1, STAFF NM1.

T+15 min:

. EFW Keep probes (1234) in mode (EEEE)

. EFW Set optimum Ibias -40(TBC) nA on probes 1+2

. EFW Perform slow sweeps as above, but on probes 3+4

T+30 min:

. EFW Keep probes (1234) in mode (EEEE)

. EFW Set optimum Ibias -40(TBC) nA on all probes

. EFW Set optimum Vguard -3(TBC) V

. EFW Set optimum Vpuck 0(TBC) V

. EFW No sweeps

T+38 min 20s:

WHISPER mode N2 (see Annex B.10)

T+41 min 40s:

WHISPER mode N1

T+50 min

WHISPER mode N4 (see Annex B.10)

WBD mode 0-77 kHz Ey antenna

T+ 50 min 08 s:

WHISPER mode S1 (see Annex B.10)

T+51 min 08 s:

WHISPER mode N4

T+51 min 16 s:

WHISPER mode S2 (see Annex B.10)

T+51 min 52 s:

WHISPER mode N4

T+52 min :

WHISPER alterned between mode S3 (see Annex B.10) and mode N1

T+78 min

WHISPER mode N4 (see Annex B.10)

T+ 78 min 08 s:

WHISPER mode S1 (see Annex B.10)

T+79 min 08 s:

WHISPER mode N4

T+79 min 16 s:

WHISPER mode S2 (see Annex B.10)

T+79 min 52 s:

WHISPER mode N4

T+80min:

WHISPER mode N1

T+83min 20s:

WHISPER mode N2

T+83min 45s:

WHISPER Standby

T+84 min:

. EFW Set probes (1234) in mode (DDEE)

. EFW Set optimum Ibias -40(TBC) nA on probes 3+4

. EFW Perform slow voltage sweep on probes 1+2 once every 2 spins, stepping

Vguard = {-5, 0, +5} V (values TBC)

Vpuck = {-0.5, 0, +0.5} V (values TBC)

Vbias = {-20, -10, 0, +10, +20} V (values TBC)

Sweep parameters are defined by the above settings:

3 guard values between -5 V and +5 V (values TBC)

3 puck values between -0.5 V and +0.5 V (values TBC)

5 voltage values between -20 V and +20 V (values TBC)

2 spins at each voltage step

WBD (TBD)

T+90 min:

. EFW Set probes (1234) in mode (EEDD)

. EFW Set optimum Ibias -40(TBC) nA on probes 1+2

. EFW Perform slow voltage sweeps as above, but on probes 3+4

WHISPER mode N1

T+96 min:

. EFW Keep probes (1234) in mode (EEDD)

. EFW Set optimum Vbias +5(TBC) V on probes 3+4

. EFW Perform slow current sweep on probes 1+2 once every 2 spins, stepping

Vguard = {-10, -5, 0, +5, +10} V (values TBC)

Vpuck = {-1, -0.5, 0, +0.5, +1} V (values TBC)

Ibias = {+60, 0, -60, -120, -180, -240, -300, -360, -420} nA (values TBC)

Sweep parameters are defined by the above settings:

5 guard values between -10 V and +10 V (values TBC)

5 puck values between -1 V and +1 V (values TBC)

9 current values between +60 nA and -420 nA (values TBC)

2 spins at each current step

T+126 min:

. EFW Keep probes (1234) in mode (EEDD)

. EFW Set optimum Ibias -40(TBC) nA on probes 1+2

. EFW Set optimum Vbias +5(TBC) V on probes 3+4

. EFW Set optimum Vguard -3(TBC) V

. EFW Set optimum Vpuck 0(TBC) V

. EFW No sweeps

STAFF DESPIN OFF

WBD in mode 0-77 kHz Ez antenna

T+136 min:

. EFW Set probes (1234) in mode (EEEE)

. EFW Set optimum Ibias -40(TBC) nA on probes 1+2

. EFW Set optimum Ibias -40(TBC) nA on probes 3+4

STAFF DESPIN ON

T+136min 40s:

WHISPER mode N2

T+140 min:

WHISPER mode N4

T+146 min

WHISPER mode S1

T+147 min

STAFF mode EM

WHISPER mode N4

T+147 min 8s:

WHISPER mode S2

T+147 min 44s:

WHISPER alternating between mode N4 and S4 (see Annex B.10)

T+164 min 32s:

STAFF mode NM1

WHISPER alternating between mode S3 and N3 (see Annex B.10)

T+ 178 min 32s:

WHISPER mode N4

T+180 min:

[end of 3 h WEC diagnostics]

The full command sequence is provided in WEC_COMMISS_B10 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedures are FCP_WEC_CA15, FCP_WEC_CB15 and FCP_WEC_CC15.

B.11 *WBD BM2 diagnostics* (15 min non real time)

See B.9. If the BM2 diagnostics were run at B9 the DSN diagnostics will be run here if DSN is available, otherwise this step may be omitted.

C .SECOND DEPLOYMENT

WEC request is that all the other experiments are OFF except FGM from C.1 to C.6, for C.7 and C.8 it is TBD.

C.1 *WEC status*

Only DWP and EFW are ON. Real time tm is required. . The ESOC procedure is FCP_WEC_C017.

C.2 *Boom deployment*

Deployment boom 3&4 20-35 m (30 min realtime)

During 2nd boom deployment

T+0 min:

. Set probes (1234) in mode (EEEE)

. Set optimum Ibias -40(TBC) nA on all probes

. Set optimum Vguard -3(TBC) V

. Set optimum Vpuck 0(TBC) V

. No sweeps

. Start deployment booms 3+4 at 20 m, 22 rpm

T+25 min:

. Stop deployment booms 3+4 at 35 m, 16.1(TBC) rpm

The full procedure is provided in EFW_COMMISS_C2 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C018.

C.3 *Boom deployement*

Deployement boom 1 &2 20 - 35 m (30 min realtime)

T+0 min:

. Set probes (1234) in mode (EEEE)

. Set optimum Ibias -40(TBC) nA on all probes

. Set optimum Vguard -3(TBC) V

. Set optimum Vpuck 0(TBC) V

. No sweeps

. Start deployment booms 1+2 at 20 m, 16.1(TBC) rpm

T+25 min:

. Stop deployment booms 1+2 at 35 m, 12.7(TBC) rpm

The full procedure is provided in EFW_COMMISS_C3 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C019.

C.4 *EFW diagnostics*

After 2nd boom deployment (30 min realtime)

identical to B.6

C.5 *WHISPER diagnostics*

same as B.7.b but without STEP 0. The total duration is 30 minutes.

Test duration about 19 min, not including interstep pauses.

The full procedure is given in WHI_COMMISS_C5 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C020.

C.6 *STAFFdiagnostics*

same as B.8

C.7 *WEC diagnostics* (4 x 3 h non realtime during 1 orbit)

All WEC during 1 orbit. Identical to B.10

C.8 *WBD BM2 diagnostics* (15 min non real time)

Identical to B.11

D. THIRD DEPLOYMENT

WEC requests that all the other experiments are OFF except FGM from D.0 to D.6, for D.7 to D.12 it is TBD (possibly ASPOC ON).

D.0 *S/C manoeuvre*

Spin up to 20 rpm (10 mn realtime)

T+0 min:

. Start spin up at 12.7(TBC) rpm

T+5(TBC) min:

. Stop spin up at 20 rpm

D.1 *WEC status*

Only DWP and EFW on. Real time tm is required. . The ESOC procedure is FCP_WEC_C017.

D.2 *Boom deployement* 3+4 35 - 45.5 m (30 min realtime)

During 3rd boom deployment

T+0 min:

. Set probes (1234) in mode (EEEE)

. Set optimum Ibias -40(TBC) nA on all probes

. Set optimum Vguard -3(TBC) V

. Set optimum Vpuck 0(TBC) V

. No sweeps

. Start deployment booms 3+4 at 35 m, 20 rpm

T+17.5 min:

. Stop deployment booms 3+4 at 45.5 m, (TBD) rpm

The full procedure is provided in EFW_COMMISS_D2 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C023.

D.3 *S/C manoeuvre* (10 min realtime)

Spin up to 15 rpm
T+0 min:
. Start spin up at (TBD) rpm
T+1(TBC) min:
. Stop spin up at 15 rpm

D.4 *EFW diagnostics* (30 min realtime)
After 3rd boom deployment
identical to B.6

D.5 *WHISPER diagnostics*
same as C.5

D.6 *STAFF diagnostics*
A modified version of the tests in B.8 will be run.

The full sequence is provided in STA_COMMISS_D6 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C032.

D.7 *WEC diagnostics*
identical to B.10

D.8 *WBD BM2 diagnostics*
identical to B.9

D.9 *WEC diagnostics*
identical to B.10

D.10 *WBD BM2 diagnostics*

identical to B.9

D.11 *WEC diagnostics*

identical to B.10

D.12 *WBD BM2 diagnostics*

identical to B.9

E. FOURTH DEPLOYEMENT

WEC request is that all the other experiments are OFF except FGM from E.1to E.6, for E.7 to E.10 it is TBD.

E.1 *WEC status*

Only DWP and EFW are operated. Real time tm is required. . The ESOC procedure is FCP_WEC_C017.

E.2 *Boom deployement* 1+2 35-50 m (30 min realtime)

During 4th boom deployment (30 min realtime)

T+0 min:

. Set probes (1234) in mode (EEEE)

. Set optimum Ibias -40(TBC) nA on all probes

. Set optimum Vguard -3(TBC) V

. Set optimum Vpuck 0(TBC) V

. No sweeps

. Start deployment booms 1+2 at 35 m, 15 rpm

T+17.5 min:

. Stop deployment booms 1+2 at 45.5 m, (TBD) rpm

The full procedure is provided in EFW_COMMISS_E2 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C026.

E.3 *S/C manoeuvre* (10 min realtime)

Spin up to 15 rpm
T+0 min:
. Start spin up at (TBD) rpm
T+4(TBC) min:
. Stop spin up at 15 rpm

E.4 *EFW diagnostics* (30 min realtime)
After 4th boom deployment
identical to B.6

E.5 *Whisper diagnostics.*
same as C.5

E.6 *STAFF diagnostics*
same as B.8

E.7 *WEC diagnostics* (4 x 3 h non realtime during 1 orbit)
All WEC during 1 orbit. Identical to B.10

E.8 *WBD BM2 diagnostics*
Identical to B.9

E.9 *WEC HBR diagnostics*
(4 x 30 min non realtime during 1 orbit)

E.9.1 EFW

During the test EFW will be run in in its highest TM rate (tape mode 3). This means that most other WEC instruments must be OFF or in an idle state. The STAFF-SC instrument needs to be powered on but with no telemetry output.

The full sequence is provided in the WEC_COMMISS_E9.1 part of WEC_COMMISS_E9 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C028.

E.9.2 STAFF diagnostics in burst mode

The calibration in burst mode is the only way to verify the transfer function of the 180 Hz filters, and allows verification that the SA fast modes work.

At the end, a test to intercalibrate the E measurements between EFW and STAFF SA in the 10-180 Hz is foreseen. this can take place elsewhere, but needs burst mode 1.

Time (minutes)	Mode
00	STAFF SC = BM (with compression)
	STAFF SA = FM2
05	DESPIN OFF
	CAL ON
08	DESPIN ON
	STAFF SA STANDBY (or ON if EFW OFF)
	STAFF SC = EMHBR (no compression)
	CAL ON
11	STAFF SC = BM (compression)
	STAFF SA = NM1
	EFW ON in wave mode EEEE (in BM filters at 180 Hz)
13	STAFF SA = FM2
15	end of specific STAFF test

The full command sequence is provided in the WEC_COMMISS_E9.2 part of WEC_COMMISS_E9 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING**

COMMAND SEQUENCES" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C029.

STAFF diagnostic period

Test of the different modes of SA and of the compression of MWF data, (the wave diagnostic must stay simple).

STAFF asks for Cal mode in NM with no compression, then with compression 1 and compression 2.

The same is asked for BM.

This makes about 45 minutes altogether.

In different plasma regions, STAFF asks for tests for MWF in EM and NM with no compression, compression 1 and compression 2 (at least on one S/C).

Cal mode must be also run with DESPIN On and DESPIN Off.

To intercalibrate the 10-180 Hz electric field data: HBR EFW mode, STAFF MWF in BM (450 Hz), STAFF SA in NM1, DESPIN Off.

Also a test of patching S/W should be done.

WHISPER E.9.

WHISPER part of WEC HBR diagnostics in commissioning step E.9.
The purpose of the Gliding mode options are:-
(a) Tuning of Whisper commands in HBR Spin sync gliding by trying several gains and emission levels.
(b) Susceptibility of STAFF by trying several frequency tables.
(c) Complementarity with EFW density measurements by comparing with EFW probes all in E mode, ASPOC off and with EFW with 2 probes in D mode, ASPOC ON.
The basic duration of each run is 36 spins.
The purpose of the HBR continuous mode options are:-
(a) Tuning of the Whisper commands in HBR Continuous by trying several emission levels and frequency tables.
(b) Complementary with EFW density measurements by comparing with EFW probes all in E mode, ASPOC off and with EFW with 2 probes in D mode, ASPOC ON.

The test takes approx. 1 hour.

The full command sequence is provided in the WEC_COMMISS_E9.b and WEC_COMMISS_E9.c parts of WEC_COMMISS_E9 of the document **CL-WEC-CS-001**

"THE WEC COMMISSIONING COMMAND SEQUENCES" which is ***Annex CCS 1*** to the WEC User Manual. The ESOC procedures are FCP_WEC_C030 and FCP_WEC_C031.

E.10 *WBD BM2 diagnostics*

Identical to B.9

F. OTHER TESTS

WEC request is that all the other experiments are OFF except FGM from F.1to F.6, for E.7 to E.10 it is TBD.

F.1 *Full EFW tests* (2 h non realtime)

EFW commands (TBD). The ESOC procedure is FCP_WEC_C033.

F.2 *Full WHISPER tests*

Test of the influence or not of active WHISPER on different modes in the two available regions (magnetosheath and lobes):

STEP 1. Test the sounder's behaviour with respect to specific commands, transmitter level, receiver gain, and overflow threshold. WEC mode: NBR continuous, modified. Duration 50 minutes.
STEP 2. Test Spin Sync modes (SYNC A and B modes). WEC mode: NBR Spin Sync (a) modified. Duration about 15 minutes.
STEP 3 to 8. Test different possibilities for natural wave measurements in NBR telemetry. WEC mode: NBR Langmuir a, modified. Duration at least 5 minutes with repeated loops of 104 seconds.

Overall duration 2 hours.

The full procedure is provided in WHI_COMMISS_F2 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. . The ESOC procedure is FCP_WEC_C034.

F.3 *Full STAFF tests*

For the full test, STAFF want to have calibration in the 3 compression modes (no compression, compression 1 and compression 2) and to test the different STAFF SA modes, (as in the EGSE test "SA modes")

These tests should be followed by 2 minutes in cal OFF, with STAFF SC = NM, STAFF SA= NM1. Then, to end, a test of STAFF SA S/W patch should take place.

Wave diagnostics sequence

STAFF wants to be on, in passive mode most of the time during those periods, with the maximum of measurement, compatible with a full WEC operation. Then it is asked to have

STAFF SA in NM1 and STAFF SC in NM all the time. For the time interval where Whisper needs more telemetry, STAFFSA could be in EM (: 5 components, but 2s instead of 1 second time resolution for the auto spectra). During part of the Langmuir mode , and when WHISPER is passive, DESPIN will be put off for approximately 10 minutes.

The full procedure is provided in STA_COMMISS_F3 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. The ESOC procedure is FCP_WEC_C035.

F.4 *Full WBD tests*

TBD

F.5 *Full WEC macro tests in NBR*

The ESOC procedure is FCP_WEC_C036.

F.6 *Full WEC macro tests in HBR*

The ESOC procedure is FCP_WEC_C037.

F.7 *Interference tests inside WEC*

Listening ®	EFW	SSC	SSA	WBD	WHI
ON/OFF ¯					
EFW		X	X		
SSC	X		X	X	X
SSA	X	X		X	X
WBD	X	X	X		X
WHI	X	X	X	X	
WTX	X	X	X	X	

Two procedures are used, one using BM2 telemetry (but not always for WBD data) and the other using NM1 telemetry plus WBD to DSN. The full procedures are provided in WEC_COMMISS_F7 (BM2) and WEC_COMMISS_F8 (DSN) of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. The ESOC procedures are FCP_WEC_C047 (BM2) and FCP_WEC_C048 (DSN).

NOTES

1. The desired spin rates are based on an assumed spacecraft roll moment of inertia 700 kg m² at the start of wire boom deployment. The objective is to not exceed 4 G's at the sensor during the first 20 meter deployments. These spin rates should be recalculated before in flight deployments.

2. The limit on the nutation of the Cluster satellite in order to deploy the EFW wire booms is different for the start of the deployment, when the spheres are still in their casing, and later on during the deployment, when only the wire has contact with the boom deployment unit. Initially, the nutation should be below 3 degrees half angle, in order that the spheres not make contact with the housing. Later on, the nutation limit is relaxed considerably to, say, 45 degrees half coning angle, since the wire booms are not stiff, and consequently do not break like stiff booms do.

3. WEC-1 and WEC-2 are the Z_e boom pair, while WEC-3 and WEC-4 are the Y_e boom pair. WEC-1 represents the $+Z_e$ axis, in the spacecraft -Y, +Z quadrant. WEC-3 represents the $+Y_e$ axis, in the spacecraft +Y, +Z quadrant. The Y_e boom pair is the WHISPER transmitter.

4. The stated lengths are the radius from the centre of the vehicle to the sphere. The initial sphere radius is 1.3 meters, meaning the first wire deployment strokes should be only 18.7 meters.

5. The deploy and spin sequence has been altered to allow for a few weeks of data with unequal boom dipoles (40 and 84 meters) on each spacecraft. Minor adjustments of spin rate are included to keep the spin closer to the 15 RPM nominal value, and increase the initial G margin.

Operational safety

1/ To prevent inadvertent deployments, keep motor power OFF unless deploying.

2/ No damage to units will result from power to booms with doors closed, unless the condition persists for several minutes or more. EFW deployment software stops deployment (or will not start it) when either door is closed.

3/ high voltage (100 V) supplies will not be damaged by power cycling (ON-OFF-ON).

4/ No damage will result from shorted load in booms.

Turn ON sequence

1/ turn OFF + 28 V motor power

2/ turn ON DWP main electronic package

3/ turn ON EFW main electronic package

4/ verify AOS

5/ send EFW configuration command sequence

6/ verify command load

Command/memory load requirements

1/ commands per load = up to 250 (1K program)

2/ frequency = 1/month if we write fast

3/ verification = command verified in EFW TM, checksum performed before execution.

Real-time data requirements

1/ real time data from EFW required to support sensor diagnostics

2/ maximum time delay no greater than a few minutes

3/ total duration of commanding = 5-15 minutes depending upon real-time delay

4/ currently in planning stages.

5.4 HIGH VOLTAGES ON

There is no high voltage ON. WHISPER is not to turn ON the transmitter before the booms are partially released.

5.5 IEL (Inter Experiment Link) and MULTI-INSTRUMENT FUNCTIONAL TESTS

and MULTI-INSTRUMENT FUNCTIONAL TESTS

G.1	Test of IEL (Inter Experiment Link)
G.2	DWP (Correlator)/PEACE combined functional test.
G.3	Interference Tests with experiments outside WEC.

These must be performed after all appropriate instruments are commissioned.

G.1 *Test of IEL*

Tests of the IEL might include:

- DWP (correlator) / PEACE
- FGM / EFW (via DWP)
- DWP to EDI
- DWP to ASPOC
- DWP to CIS
- STAFF to EDI

No procedures are presently defined, except for the Whisper/ASPOC interference tests (FCP_WEC_C042 to FCP_WEC_C045) to be run as part of the ASPOC commissioning, and the PEACE/DWP correlator test included as G2 below.

G.2 *PEACE/DWP tests*

A test needs to be done after WEC and PEACE have been individually commissioned. A correlator test taking about 60 minutes should be carried out on each spacecraft. For the first CLUSTER to be commissioned this test should be repeated in a maximum of 4 regions in geospace.

The full procedure is provided in WEC_COMMIS_G2 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. The ESOC procedure is FCP_WEC_C049.

G.3 *Interference tests*

When all instruments on a s/c have been commissioned, interference tests between WEC and other instruments may be performed. These tests constitute the interference campaign which will be run through the mission planning system and co-ordinated by JSOC. WEC wishes to check for

interference from all other instruments. The campaigns are described in detail on the JSOC web site for the scientific working team at:

`http://jsoc1.bnsc.rl.ac.uk/DOC/interference_campaign/if_campaign.html`

Briefly the campaigns are:

- S/C potential campaign (ASPOC, EDI, EFW, WHISPER), with CIS & PEACE participation,
- EDI campaigns (electron interference to PEACE, CIS; beam current effects on STAFF; beam modulation and instabilities on WEC),
- WHISPER campaigns (active ops effects on CIS, PEACE, EDI).

The need to repeat all campaigns in different plasma environments is emphasized. As some regimes are not encountered until well into the mission, it is clear that campaigns will have to be scheduled over much of the first year. No real time tm is required.

STAFF wants to be on as often as possible to listen to any possible interference, in particular at any switch on of other experiments. In particular, FGM should be turned OFF and ON again, at any time during the commissioning phase. Specific tests of the influence of the EDI modes on STAFF mwf have to be foreseen in different plasma conditions (field orientation, intensity).

5.6 CROSS CALIBRATION

Cross calibration of the scientific data will be performed as discussed in the Klaus Torkar (1994) document.

5.7 Annex A.4 FIRST Full WEC ON PROCEDURE

Annex of the WEC User Manual paragraph: Chapter 5.2 Section.A.4

1. Initial Conditions

1.1 The following procedure is defined for the first phase of the commissioning, when the whole WEC experiment has never been turned ON so far (in flight). However, it can also be used at any further moment if a technical problem is suspected. It is assumed that the spacecraft sub-systems are already tested and are operating nominally.

1.2 The following operations consist to turn ON the PWR and DWP units first (WEC ON) and, then, all WEC instruments, with a real time verification of the main integrity of the experiment. It will prove that WEC can be powered ON in nominal conditions but the individual experiments are not completely tested.

1.3 The procedure will be conducted by ESOC but all verifications and decisions concerning the WEC will be under the control of a WEC conductor nominated for that purpose. The conductor will be supported by other WEC members to form a small group responsible for this stage of the commissioning.

1.4 The real time verifications shall be made from a console connected to the ESOC system and not with the WEC /EGSE. Such a terminal must be dedicated to the commissioning team, situated in a quiet area (preferably in the operation centre). The WEC conductor must be in direct and permanent communication with the ESOC operator.

1.5 For the commissioning, the WEC EGSE will also be in operation to collect the data for more detailed analysis, and to define contigency operations in case of problems.

1.6 For real time verifications, a list of parameters will be displayed on the dedicated terminal before starting the procedure. Requested lists shall be prepared in advance, and validated in training sessions.

1.7 The ESOC operator must be prepared to turn WEC OFF immediately on request from the WEC conductor, at any moment.

1.8 In case a wrong result induces a WEC TURN OFF, a short meeting will be held with ESOC/ESTEC and WEC representatives to define the best contigency procedure. A general guide-line is given in par: 20. In case of problem, outgoing actions for normal operations will be evaluated at the end of the test.

1.9 If any uncontrolled circumstance arrives, WEC will be turned OFF until recovery of a good control of the operations. The procedure will be restarted with a method specified by the WEC conductor.

1.10 Parameters to be displayed, initial value.

34 parameters are requested to control the real time operations. All of them are supposed to be visible on the screen at the same time. If possible, they will be displayed in separated groups to facilitate a quick identification of the right parameter.

PLWECA_S WEC LCL/A status	"OFF"
PLWECB_S WEC LCL/B status	"OFF"
??? WEC LCL/A Current	offset (<10mA)
??? WEC LCL/B Current	offset (<10mA)
EW5WECCS WEC Current Sense	not active
EW5VMON DWP Voltage Monitor	not active
EW5MOTAG DWP Model Tag	not active
EW5RSCNT OBDH reset count	not active
EW5WECMX WEC Macro executing	not active
EW5KPNUM DWP kernel processor module	not active
EW5NFAIL OBDH nom. channel failure	not active
EW5RFAIL OBDH red. channel failure	not active
EW0PWRST EFW power status	not active
EW0NOTLM EFW no telemetry received	not active
EW2PWRST STA/SC power status	not active
EW2EWORD STA/SC error word	not active
EW2CALMD STA calibration mode	not active
EW2VMON0 STA/SC voltage monitor -9V	not active
EW2VMON1 STA/SC voltage monitor -5V	not active
EW2VMON2 STA/SC voltage monitor +9V	not active
EW2VMON3 STA/SC voltage monitor +5V	not active
EW1PWRST STA/SA power status	not active
EW1EWORD STA/SA error word	not active

EW1AMODE STA/SA analysis mode	not active
EW1VMON0 STA/SA voltage monitor +6V	not active
EW1VMON1 STA/SA voltage monitor -6V	not active
EW1VMON2 STA/SA voltage monitor +5V	not active
EW3PWRST WHISPER power status	not active
EW3TXPST WHIS/TX power status	not active
EW3PMODE WHISPER primary mode	not active
EW3CALRL WHISPER calibration result	not active
EW4PWRST WBD power status	not active
EW4VMON0 WBD voltage monitor +6V	not active
EW4VCXOL WBD VCXO lock status	not active

1.11 Turn OFF Procedure

In case WEC must be turned OFF, this will be made as follows:

send command ZEWMSFFS, 0x80 --stop any running Macro
send command ZEWMSFFS, 0x1F --turn OFF all WEC instruments
wait 5s
send command ZWECAFFN -- turn OFF LCL A
send command ZWECAFFN -- turn OFF LCL B

2. WEC (PWR+DWP) ON - Main Power line

(the same procedure will be repeated with the Red Power line)

2.1 Turn WEC ON - LCL A

send command ZWECAONN	(TBC)	WEC LCL A ON
send command ZEXEMLCA	(TBC)	execute ML Command
wait 5s		
send command ZEWMSFFS, 0x80		inhibit Default Macro

2.2 Wait about 20 s and verify the following expected changes in the parameters.

PLWECA_S	WEC LCL/A status	"ON"
PLWECB_S	WEC LCL/B status	"OFF"
???	WEC LCL/A Current	0.070 A
???	WEC LCL/B Current	offset

EW5WECCS WEC Current Sense	0.070 A
EW5VMON DWP Voltage Monitor	5 V [4.3 5.5]
---	---
EW5MOTAG DWP Model Tag	CD01 to CD04
EW5RSCNT OBDH reset count	incremented by 1 every 5s
EW5WECMX WEC Macro executing	0x00
EW5KPNUM DWP kernel processor module	0x02
EW5NFAIL OBDH nom. channel failure	0x00
EW5RFAIL OBDH red. channel failure	0x00
---	---

All other parameters must remain not active

2.3 If any of the following unexpected result arrives:
then TURN WEC OFF according to 1.11

2.3.1 LCL Current too large > 90 mA

2.3.2 LCL Current too small < 50 mA

2.3.3 Model Tag not as expected

2.3.4 Reset counter not running

2.3.5 Current Sense too large > 90 mA

2.3.6 Current Sense too small < 50 mA

2.3.7 DWP Voltage Monitor out of limits
(according to the AIT DB definition)

2.3.8 DWP or OBDH status not nominal

2.3.9 any other status activated

2.4 If WEC has been switched OFF, analyse the recorded data and the situation to define how to continue, according to the contingency recommendations given in par: 20

TEST COMPLETED UNTIL FURTHER DECISION

2.5 Otherwise, wait 20 s more to be sure that the WEC Default Macro is not started by DWP. The effect of the Macro is to turn ON all WEC instruments (but WBD) one after the other.

2.5.1 If the Default Macro is started, the input current increases. This is equivalent to 2.3.1 or 2.3.5

TURN WEC OFF and see actions of 2.4

2.5.2 Otherwise, continue to 3.

3. EFW ON

3.1 Turn EFW ON

send command ZEWMS2FS, 0x40 EFW ON

3.2 Wait about 20 s and verify the following expected changes in the parameters.

???	WEC LCL/A Current	0.190 A
EW5WECCS	WEC Current Sense	0.190 A [+0.120]
EW0PWRST	EFW power status	"ON"
EW0NOTLM	EFW no telemetry received	0x00

3.3 If any of the following unexpected result arrives:

then TURN WEC OFF according to 1.11

3.3.1	Current Sense	too large > 230 mA
3.3.2	Current Sense	too small < 170 mA
3.3.3	Power Status	not "ON"

3.4 If WEC has been switched OFF, analyse the recorded data and the situation to define how to continue, according to the contingency recommendations given in par: 20

TEST COMPLETED UNTIL FURTHER DECISION

3.5 If EW0NOTLM = 0x01, there is a problem with the exchange of data within EFW and DWP, to be analysed off line, but the Turn ON procedure will continue.

4. STAFF/SC ON

4.1 Turn STAFF/SC ON
send command ZEWMS2FS, 0x42 STAFF/SC ON

4.2 Wait about 20 s and verify the following expected changes in the parameters.

???	WEC LCL/A Current	0.235 A
EW5WECCS	WEC Current Sense	0.235 A [+0.045]
EW2PWRST	STA/SC power status	"ON"
EW2CALMD	STA calibration mode	" "
EW2VMON0	STA/SC voltage monitor -9V	-9.00 V [-9.45 -8.55]
EW2VMON1	STA/SC voltage monitor -5V	- 5.75 V [-6.20 -4.60]
EW2VMON2	STA/SC voltage monitor +9V	+ 9.00 V [+8.55 +9.45]
EW2VMON3	STA/SC voltage monitor +5V	+ 5.75 V [+5.45 +6.05]

4.3 If any of the following unexpected result arrives:
then TURN WEC OFF according to 1.11

4.3.1	Current Sense	too large > 270 mA
4.3.2	Current Sense	too small < 220 mA
4.3.3	any Voltage Monitor out of limits (according to the AIT DB definition)	
4.3.4	Power Status	not "ON"

4.4 If WEC has been switched OFF, analyse the recorded data and the situation to define how to continue, according to the contingency recommendations given in par: 20

TEST COMPLETED UNTIL FURTHER DECISION

4.5 If EW2EWORD not 0x00, there is a problem in the experiment, to be analysed off line, but the Turn ON procedure can continue.

5. STAFF/SA ON

5.1 Turn STAFF/SA ON

send command ZEWMS2FS, 0x41 STAFF/SA ON

5.2 Wait about 20 s and verify the following expected changes in the parameters.

???	WEC LCL/A Current	0.325 A
EW5WECCS	WEC Current Sense	0.325 A [+0.090]
EW1PWRST	STA/SA power status	"ON"
EW1EWORD	STA/SA error word	0x00
EW1AMODE	STA/SA analysis mode	"PASSIVE"
EW1VMON0	STA/SA voltage monitor +6V	+ 6.0 V [+4.70 +6.30]
EW1VMON1	STA/SA voltage monitor -6V	- 6.0 V [-6.30 -5.70]
EW1VMON2	STA/SA voltage monitor +5V	+ 5.4 V [+5.15 +5.65]

5.3 If any of the following unexpected result arrives:
then TURN WEC OFF according to 1.11

5.3.1	Current Sense	too large > 360 mA
5.3.2	Current Sense	too small < 290 mA
5.3.3	any Voltage Monitor out of limits (according to the AIT DB definition)	
5.3.4	Power Status	not "ON"

5.4 If WEC has been switched OFF, analyse the recorded data and the situation to define how to continue, according to the contingency recommendations given in par: 20

TEST COMPLETED UNTIL FURTHER DECISION

5.5 If EW1EWORD not 0x00, there is a problem in the experiment, to be analysed off line. The next step 5.6 will be skipped but the rest of the Turn ON procedure will continue.

5.6 run the STAFF Calibration by the commands:

send command ZEWMSFFS, 0x80	stop any running Macro
wait 5 s	
send command ZEWCS0FS, 0x100	STAFF calibration

The duration of the calibration is 6 minutes. During this time, EW2CALMD = "CAL MODE" and EW1AMODE will take several values. The last one is "NORM_1". This will be analysed off line and the Turn ON procedure will continue after completion of the Calibration.

6. WHISPER ON

6.1 Turn WHISPER ON and run a short test

send command ZEWMS2FS, 0x43	WHISPER ON
wait 5 s	
send command ZEWRS0FS, 0xD0	WHISPER quiet calibration
send command ZEWRS1FS, 0x08	--
send command ZEWRS2FS, 0x00	--
send command ZEWRSBFS, 0x00	--

6.2 Wait about 20 s and verify the following expected changes in the parameters.

???	WEC LCL/A Current	0.405 A
EW5WECCS	WEC Current Sense	0.405 A [+0.080]
EW3PWRST	WHISPER power status	"ON"
EW3TXPST	WHIS/TX power status	"OFF"
EW3PMODE	WHISPER primary mode	"CAL.1 QUIET""
EW3CALRL	WHISPER calibration result	0xFFFF

6.3 If any of the following unexpected result arrives:
then TURN WEC OFF according to 1.11

6.3.1	WHIS/TX power status	"ON"
6.3.2	Current Sense	too large > 440 mA
6.3.3	Current Sense	too small < 370 mA
6.3.4	Power Status	not "ON"

6.4 If WEC has been switched OFF, analyse the recorded data and the situation to define how to continue, according to the contingency recommendations given in par: 20

TEST COMPLETED UNTIL FURTHER DECISION

6.5 If EW3PMOD and/or EW3CALRL are not as expected, there is a problem in the experiment, to be analysed off line, but the Turn ON procedure will continue.

7. WBD ON

7.1 Turn WBD ON
send command ZEWMS2FS, 0x44 WBD ON

7.2 Wait about 20 s and verify the following expected changes in the parameters.

???	WEC LCL/A Current	0.465 A
EW5WECCS	WEC Current Sense	0.465 A [+0.060]
EW4PWRST	WBD power status	"ON"
EW4VMON0	WBD voltage monitor +27V	6.0 V
EW4VCXOL	WBD VCXO lock status	0x00

7.3 If any of the following unexpected result arrives:
then TURN WEC OFF according to 1.11

7.3.1	Current Sense	too large > 510 mA
7.3.2	Current Sense	too small < 430 mA
7.3.3	Voltage Monitor	out of limits (according to the AIT DB definition)
7.3.4	Power Status	not "ON"

7.4 If WEC has been switched OFF, analyse the recorded data and the situation to define how to continue, according to the contingency recommendations given in par: 20

TEST COMPLETED UNTIL FURTHER DECISION

7.5 If EW4VCXOL is not nominal, there is a problem in the experiment, to be analysed off line, but the Turn ON procedure will continue.

8. TURN WEC OFF

Turn WEC OFF according to 1.11

Verify that all parameters are returned to the initial situation described in 1.10

If there is no errors so far, THE SWITCH ON SEQUENCE IS SUCCESSFUL on Main line. The Redundant line must now be verified.

9. Test of the redundant power line

All the procedure 2. to 7. shall be repeated by using the redundant power line. The commands to turn ON the LCL B are the following:

9.1 Turn WEC ON - LCL B

send command ZWECBONN (TBC)	WEC LCL B ON
send command ZEXEMLCB (TBC)	execute ML Command
wait 5s	
send command ZEWMSFFS, 0x80	inhibit Default Macro

9.2 to 14.5 repeat procedure 2.2 to 7.5 but LCL B is activated instead of LCL A.

15. WEC OFF

Turn WEC OFF according to 1.11

Verify that all parameters are returned to the initial situation described in 1.10.

If there is no errors so far, THE SWITCH ON SEQUENCE IS SUCCESSFUL on both power lines.

TEST COMPLETED

The full procedure is provided in WEC_COMMISS_A5 of the document **CL-WEC-CS-001 "THE WEC COMMISSIONING COMMAND SEQUENCES**" which is ***Annex CCS 1*** to the WEC User Manual. The ESOC procedure is FCP_WEC_C003.

5.8 Annex B.10I WHISPER WCMW and WPW ELEMENTS CHOSEN for WEC diagnostics.

I.1 N elements (DWP processing):

N1	Best frequency resolution, ~ 5s time resolution WCMW/WPW CF6060xx/0D (512bins, 116rep, 64acc.,1/6sel. rate, 8bpw)		769bps	100s
N2	Low frequency resolution, ~1s time resolution WCMW/WPW C63060xx/4F (128bins, 232rep, 8acc.,1/10sel. rate, 6bpw)		890bps	25s
N3	Medium resolutions (from NBR basic) WCMW/WPW CB1060xx/4F (256bins, 116rep, 16acc., 1/10sel. rate, 6bpw)		813bps	25s
N4	Passive reference (for continuous sounding phases) WCMW/WPW CD6060xx/0C (512bins, 8rep, 64acc, 1/4sel rate, 8bpw, 6.82s) + wait		1004bps	8s

I.2 S elements (DWP processing):

S1	Very slow sweeps (20s each), three transmission levels WCMW/WPW AD416071/12 low level AD426071/12 med. level AD436071/12 high level (2rep, 1E8R, 79steps, strat. C, 17.29s) + wait		776bps	60s
S2	Slow sweeps (12s each), three transmission levels WCMW/WPW AD416071/12 low level AD426071/12 med. level AD436071/12 high level (2rep, 1E5R, 79steps, strat. D, 10.81s) + wait		763bps	36s
S3	Short sweep (from NBR basic) WCMW/WPW AD12600E/00 med. level (to adjust) (2rep, 1E2R, mixed table 4- 80kHz, strat A, pass. red.,		2283bps)	3s

S4	NBR Continuous sounding			
	WCMW/WPW	AE226071/18	med. level (to be adjusted)	
	(32rep, 1E3R, 79 steps, strat D,		1408bps)	104s