Flight model
A model destined for orbital flight, constructed to rigourous standards, using standard components and on completion put through qualification tests.

Hermes Propulsion Module (MPH)
Hermes Resource Module (MRH)
Non-reusable part of the Hermes vehicle which is deorbited separately from the Hermes spaceplane on termination of an orbital flight.

Navigation (on board tracking)
Determines the position and the speed of the vehicle's center of gravity, the orientation of this vehicle within given reference points. This is calculated on board using readings obtained from on-board instrumentation.

Nominal
As planned and within specified limits.

In-flight operations
All surveillance and monitoring activities concerning the system and the payload on board and on the ground which must be carried out between the launch of the Ariane 5/Hermes composite and complete standstill on the runway, or at the end of a emergency return.

Mission operations
Execution of a defined mission within the mission scenario (manifesto) and use of operations in flight.

Transfer orbit
Orbit reached after 1st MRH propulsion burn.

Piloting
Function ensuring control of movement around the center of gravity in order to maintain the reference altitude required for guidance with respect to the constraints and laws of the selected attitude control.

Flight plan
Ordered sequence of operational events, activities and system configurations which serve as the basis for carrying out the mission.

Mission plan
Preparation and revision of plans prior to and during a mission for activities and use of resources (all resources on-board and on ground including crew installation time, payload manoeuvering time, communications etc.).

Reentry
Flight phase beginning at deorbit and terminating when spaceplane comes to rest on the landing strip.

Reconfiguration
Selection of a new configuration, including reference modification following anomaly detection or changes to mission objectives.

Mission scenario
Mission scheduling and definition over a period of several years, including the launch dates, the visited orbital elements, the nature of the payload, etc.

Ground segment
Parts of the system which are not used in space. Division into:
- in-flight operations subsegment
- launch subsegment
- landing subsegment
- turn around subsegment
- development means subsegment
- rescue-safety subsegment

Space segment

Person or piece of equipment for in-flight use.
All elements used either on the ground and in flight are part of the space segment.

Servicing

Activities and procedures necessary to maintaining the system and the payload, and the restocking of consummables.

Landing site

Specific geographic area on the surface of the planet where the spaceplane may land.

Ground tests

Verification method using environment or operating tests within certified and approved test installations, in accordance with test procedures and environments. The ground tests are carried out at the integration stage.

Trajectory

Geometric relation of successive positions of the center of gravity of the plane.

Hermes Space Vehicle

Vehicle which enters circular orbit after separation of a circularization stage.. It includes the Hermes Spaceplane (ASH) which returns to earth as a glider, the Hermes Resources Module (MRH) which is deorbited separately on termination of the orbital flight of the Hermes vehicle, the propulsion module (MPH), which is jettisoned at the end of the launch phase.

CHAPTER II

SITUATION OF THE FCS SUBSYSTEM WITHIN THE CONTEXT OF THE SYSTEM AND THE SPACEPLANE

2.1 The Spaceplane within the HERMES system

2.1.1 Introduction

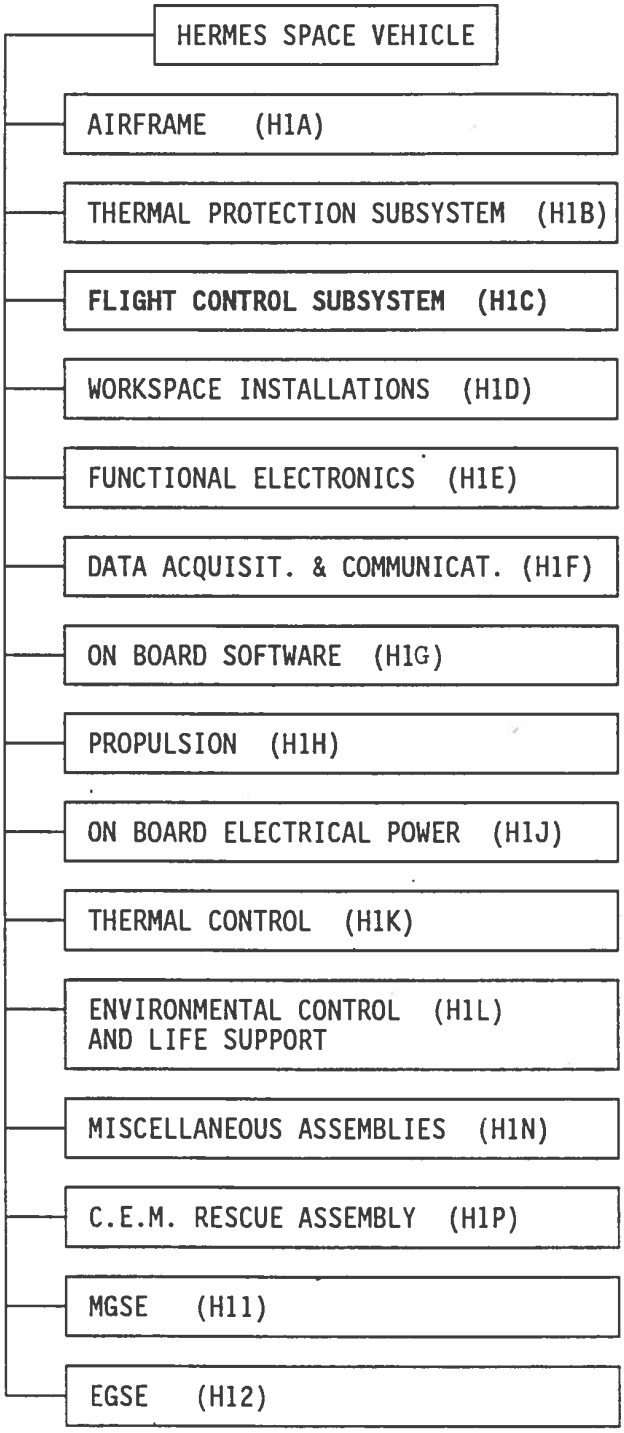
See applicable document DA1.

2.1.2 The missions

See applicable documents DA1 and DA10

2.1.3 Spaceplane - general structure

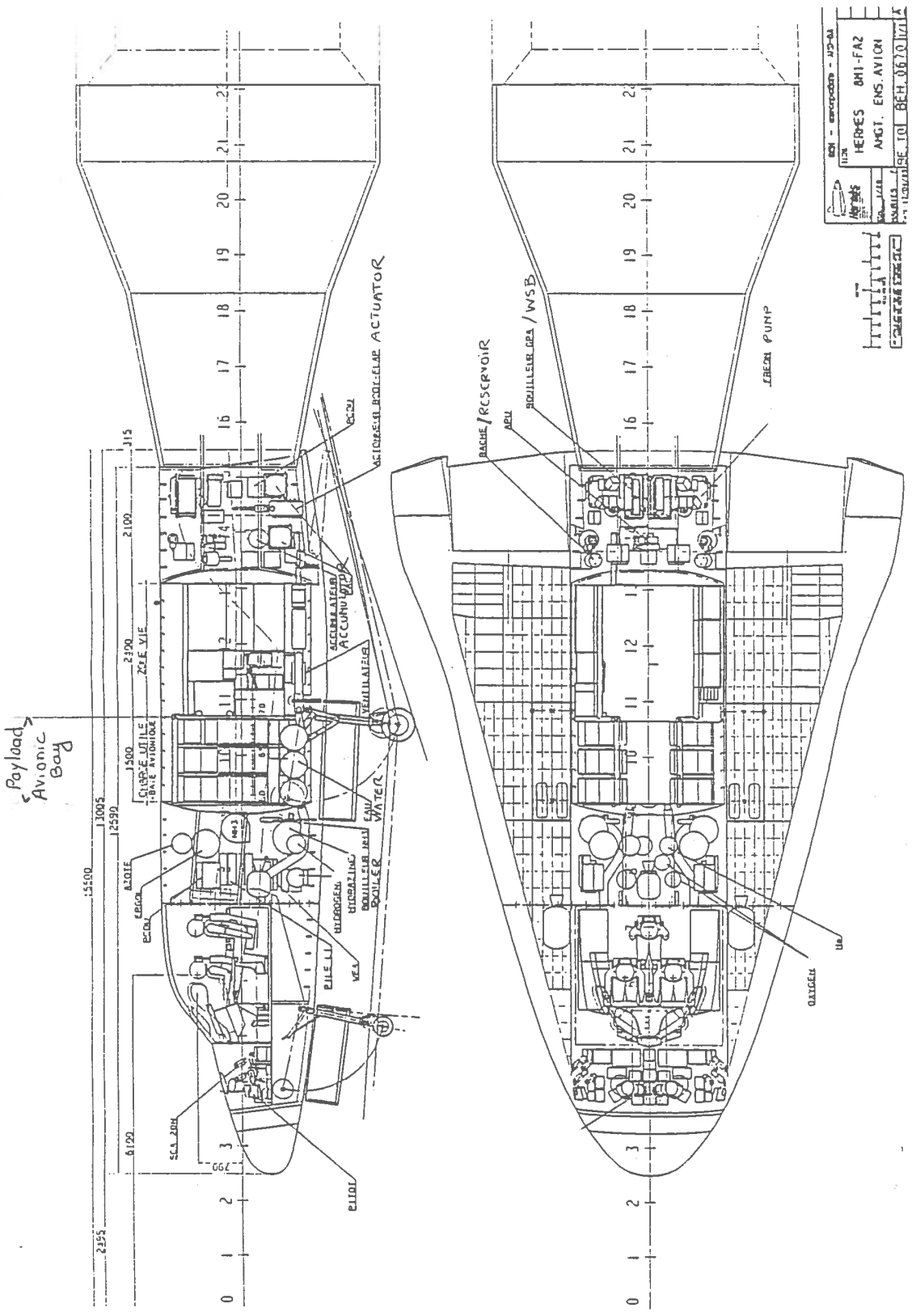
The Spaceplane has been divided into subsystems to enable a logical approach to be adopted for research and/or a first industrial breakdown (Cf. doc DA37 : Work Breakdown Structure).



Note the existance of two subsystems which are rightly speaking not part of the Spaceplane (MGSE and EGSE) but whose interfaces with the plane are such that they must be studied within the general framework of vehicle research.

2.1.4 Spaceplane configuration

A baseline for the spaceplane is envisaged as follows: (AC)



SPACEPLANE LAYOUT

2.1.5 Spaceplane spacionics

- Functional analysis DR10

- Spacionic architecture DA35

2.1.6 Mission phases

Refer to DA10

2.2 The FCS subsystem

2.2.1 Introduction

The FCS subsystem is the main support for the GPA function. The latter ensures the contol of the Spaceplane during the atmospheric phase of a mission (launch, reentry) and is implemented using hardware and software other than the FCS.

The GPA function is not linked to a single subsystem, but is obtained using:

1) Hardware: sensors, aerodynamic control surface actuators and their electronics for control, generation and distribution of power.

2) A pool of computers and their basic software programs, a network of data exchange buses, inertial units and other localisation sensors.

3) Attitude control thrusters and their control electronics.

4) Application software.

Unit 1 is part of the	FCS subsystem	(H1C)
2	SEF	(H1E)
3	Propulsion	(H1H)
4	Software	(H1G)

The requirements set out in the following paragraphs concern unit 1 and its interfaces with the other subsystems.

Equipment for the FCS is installed in every zone of the Spaceplane.

The features of each of these zones will be taken into account as regards the installation, cabling and the location of equipment.

To reply to either performance requirements or installation constraints, the following allotment can already be made:

- Airspeed-baro-clinometric sensors	:	Front zone
- Gyro-accelerometric sensors	:	Middle or central zone
- Actuators	:	Non-pressurized rear zone and wings
- Other FCS equipment	:	Non-pressurized rear zone.

The FCS controls the aerodynamic surfaces, of which there are 7 :

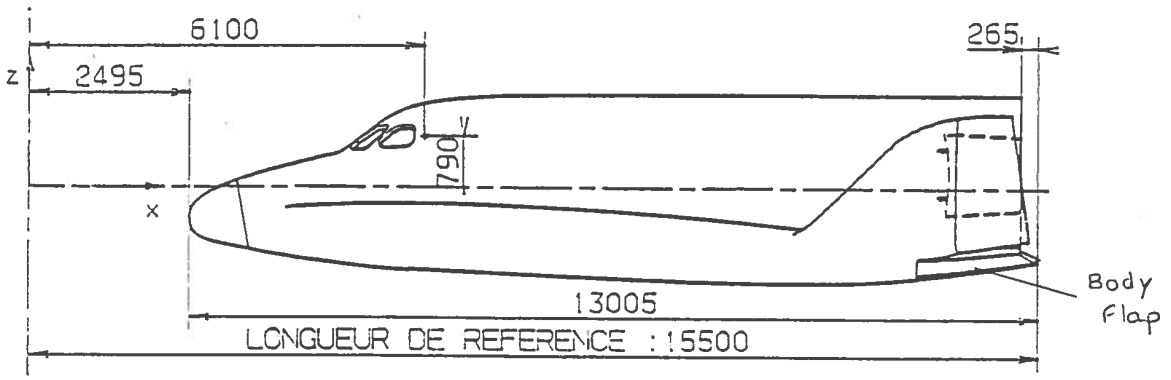
- 2 elevons which provide longitudinal trim together with the body flap, rolling lateral trim and pitch and roll control

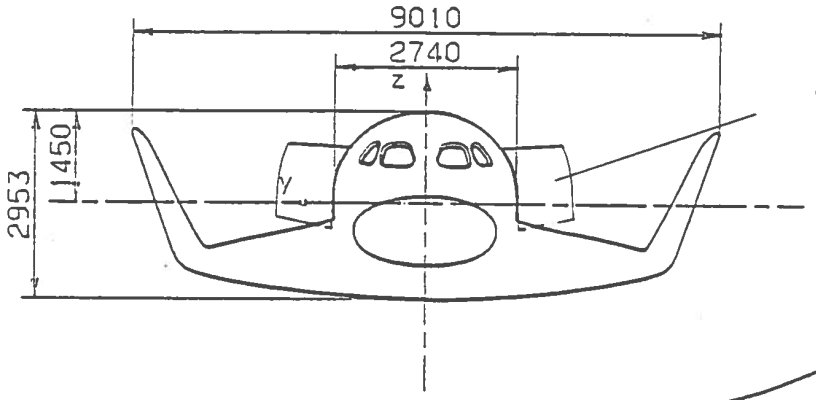
- 1 body flap to provide longitudinal trim together with the elevons,

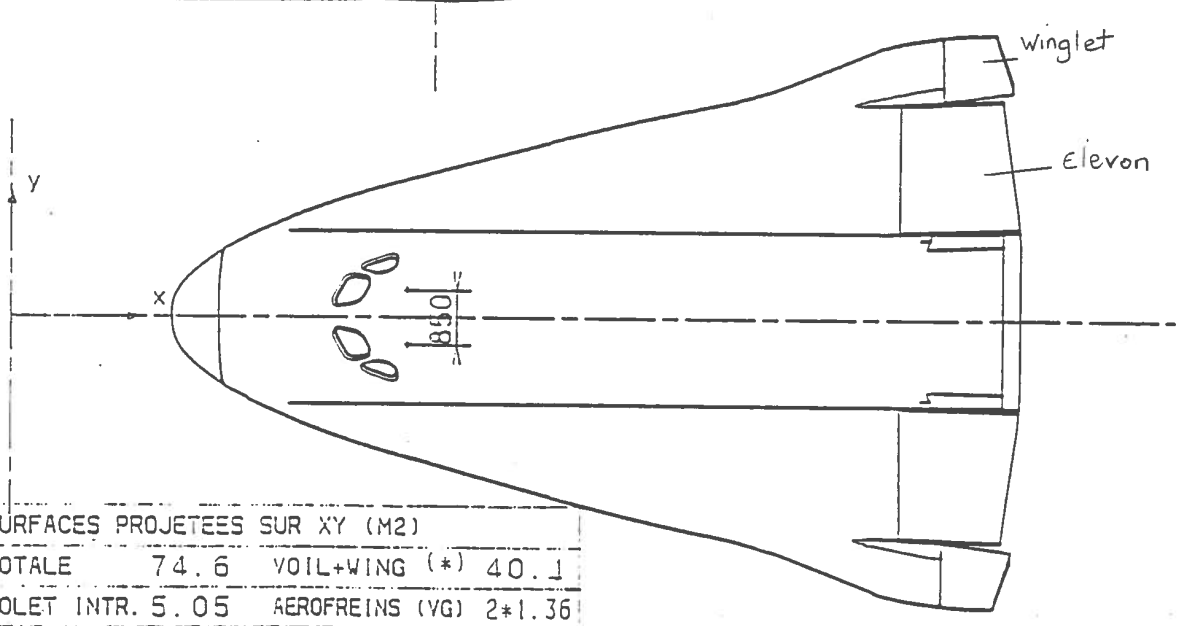
- 2 winglet rudders to provide yaw control and lateral trim,

- 2 airbrakes on the fuselage.

the location of the control surfaces is given in the following diagram (extract from DR8)
The FCS ensures ground steering during taxying (AC) and the control of the braking system.







SURFACES PROJETEES SUR XY (M2)			
TOTALE	74.6	VOIL+WING (*)	40.1
VOLET INTR.	5.05	AEROFREINS (VG)	2*1.36
ELEVONS	2*3.36	DRAPEAUX (VG)	2*2.06

(*) $y > 1370$

2.2.2 Work Breakdown Structure

In accordance with the spaceplane's WBS (DA37), the work carried out concerning the FCS has a reference number corresponding to the identification block within the WBS :

FLIGHT CONTROLS AND HYDRAULIC ASSEMBLY H1C

H1C00000	FLIGHT CONTROL SUBSYSTEM
1CA0000	- -
1CB0000	SERVO-ELECTRONICS (SVE)
1CC0000	ACTUATORS
1CCA000	ELEVON ACTUATOR
1CCB000	WINGLET ACTUATOR
1CCC000	AIRBRAKE ACTUATOR
1CCD000	BODY FLAP ACTUATOR
1CD0000	HYDRAULIC POWER GENERATION
1CDA000	APU
1CDB000	HYDRAULIC PUMP
1CE0000	HYDRAULIC DISTRIBUTION
1CEA000	RESERVOIR
1CEB000	ACCUMULATOR
1CEC000	LANDING GEAR CONTROL
1CED000	BRAKING CONTROL
1CEE000	GROUND STEERING CONTROL
1CEF000	THERMAL CONTROL
1CEN000	DISTRIBUTION MISCELLANEOUS
1CF0000	HYDRAULIC CONTROLLER
1CG0000	SENSORS
1CGA000	ABC SENSORS
1CGB000	GYROMETERS
1CGC000	ACCELEROMETERS
1CGD000	INTERFACE BOX (GPT)
1CGN000	FCS MISCELLANEOUS
1C10000	MGSE
1C20000	MGSE

CHAPTER III

FUNCTIONAL REQUIREMENTS

3.1. Functional requirements

The aim of this paragraph is to:

- locate the FCS subsystem within the Hermes spaceplane and thus identify the interfaces between this subsystem and the rest of the spaceplane;

- identify the functions of this subsystem and deduce their requirements.

The method used is that described in DR9.

If there is a text explaining a diagram it is placed before this diagram and carries the same code followed by the letter D.

a) Location of specific function of the FCS within the system

Description	Node	Date
SPECIFIC FUNCTIONS OF THE FCS IN THEIR ENVIRONMENT	RD	Page

This diagram shows the interactions between the FCS functions and the other functions or subsystems of the spaceplane.

It is important to note that the module "SPECIFIC FUNCTIONS OF THE FCS" contains all the functions specific to the FCS, even those performed by other subsystems. This is notably the case for:
- some subfunctions of the composite management, which are specific to the FCS and are supported by the computers of the FES,
- the hydraulic fluid and APUs lubricant thermal regulation, ensured by HTCAs which are part of the TCS.

The specific functions of the FCS interact with:

1) The "MCM (MISSION & COMPOSITE MANAGEMENT) COMMON FUNCTIONS"

   which role is to:
   - elaborate the status of the composite and its environment from the different status reports transmitted by the space-vehicle functions or subsystems (and among others by the FCS), or external elements (MTFF, A5, ...),
   - manage the mission, according to the mission plan and the status of the composite and its environment, and then to choose the subsystems or functions sequences to activate.
     Concerning the FCS, each sequence corresponds to a configuration envelope inside which the FCS can ensure the performing of the sequence. If the FCS status report doesn't allow to find a configuration inside the envelope, the mission management decides to change the sequence. For instance, in some cases, it can be decided to reach an ejection domain rather than to land.

2) The MMI (MAN MACHINE INTERFACE) FUNCTION

   Acquisition of dedicated commands (back-up commands) from the crew, and transmission of signals to dedicated lights, necessary to fulfill the safety & reliability objectives.

3) The GPA (GUIDANCE & PILOTING DURING REENTRY PHASE) SOFTWARE

   This software,supported by the GPCs (Guidance & Piloting Computers), sends aerosurfaces position commands & braking commands to the FCS, and receives from it formatted GPA sensors values.
   Moreover, the subfunction "manage the GPA function" of the GPA software:
   - sends a part of the GPA current configuration plan which role is to activate the FCS functions:
     . "move the aerosurfaces and actuate the main brakes",
     . "adapt & format the GPA sensors values".
   - receives the monitoring reports from these functions.

Description	Node	Date
SPECIFIC FUNCTIONS OF THE FCS IN THEIR ENVIRONMENT	RD	Page

4) The AIRFRAME

This subsystem includes the following elements linked to the FCS:
- the airbrakes moved by mechanical power from the FCS hydraulic jacks
- the hydraulic jacks anchoring points,
- the main gears brakes actuated by hydraulic power from the FCS, and the wheels rotation speed sensors which provide the necessary information to the FCS for braking control,
- the A.B.C. probes supports moved by the mechanical power from the FCS A.B.C. probes deployment devices.
- the landing gear touchdown sensors, whose output signals are formatted by the FCS to be sent to the GPA software.

5) The THERMAL PROTECTION SUBSYSTEM

which includes the aerosurfaces (airbrakes excluded) moved by mechanical power from the FCS hydraulic jacks.

4) The POWER SUBSYSTEM

which provides the primary electrical power to the FCS equipment.

5) The DAC

to which are sent the FCS technological parameters.
Nota: On the diagram, this flow of information is between brackets, because it is not necessary to represent the DAC

6) The TCS

which collects the heat from the HCTs and SVEs. (As for the technological parameters, this flow is between brackets on the diagram).

Title :

SPECIFIC FUNCTIONS OF THE FCS IN THEIR ENVIRONMENT

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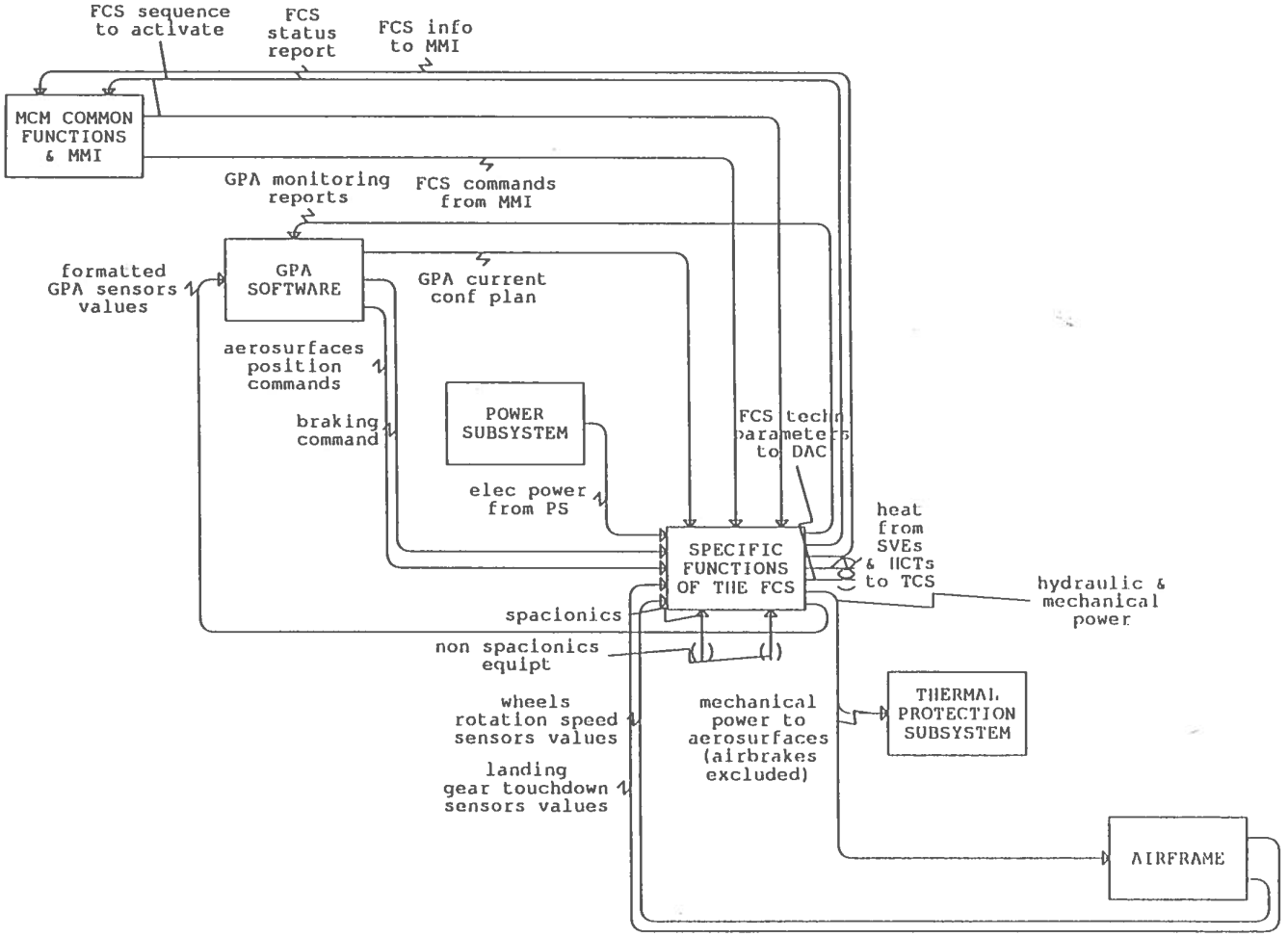

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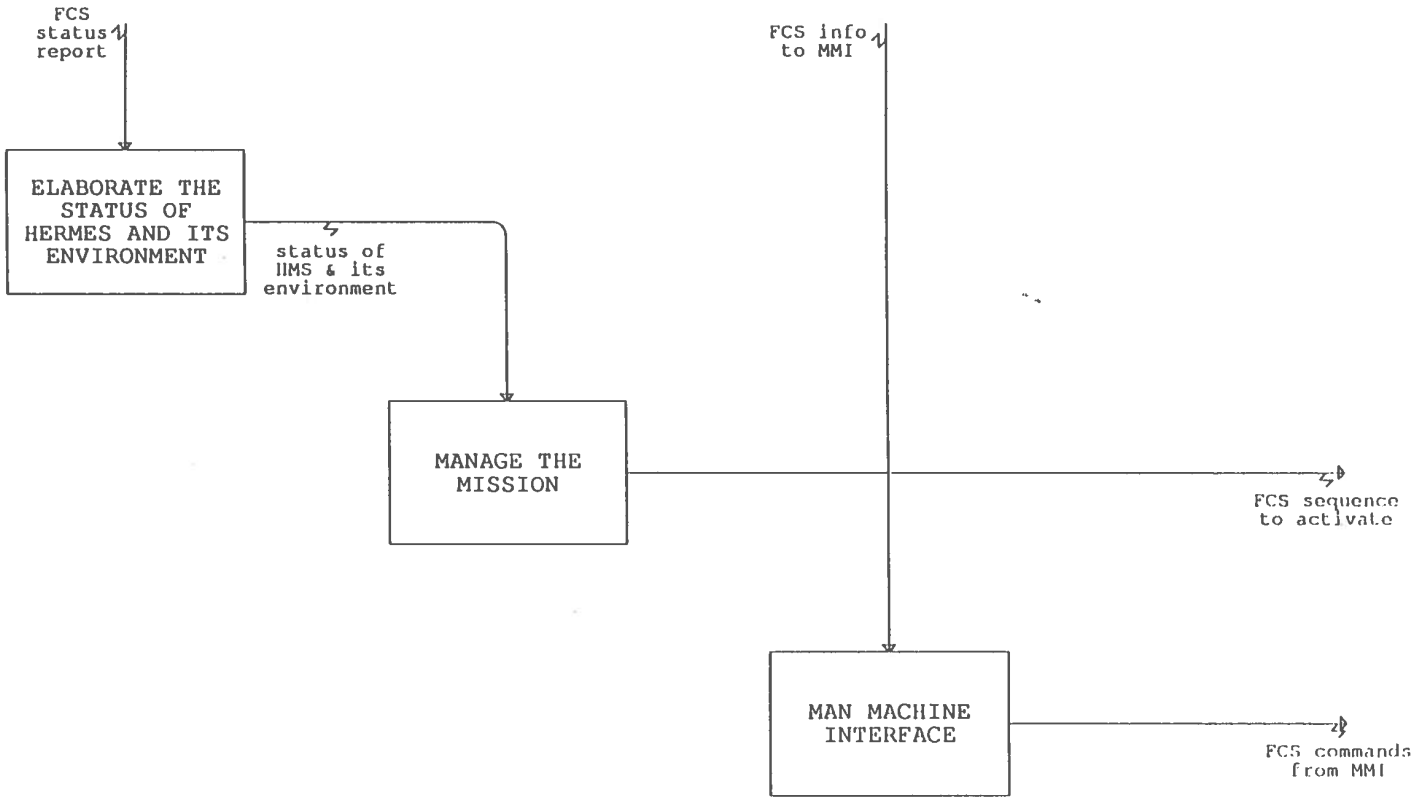
MCM COMMON FUNCTIONS & MMI	R1	Page



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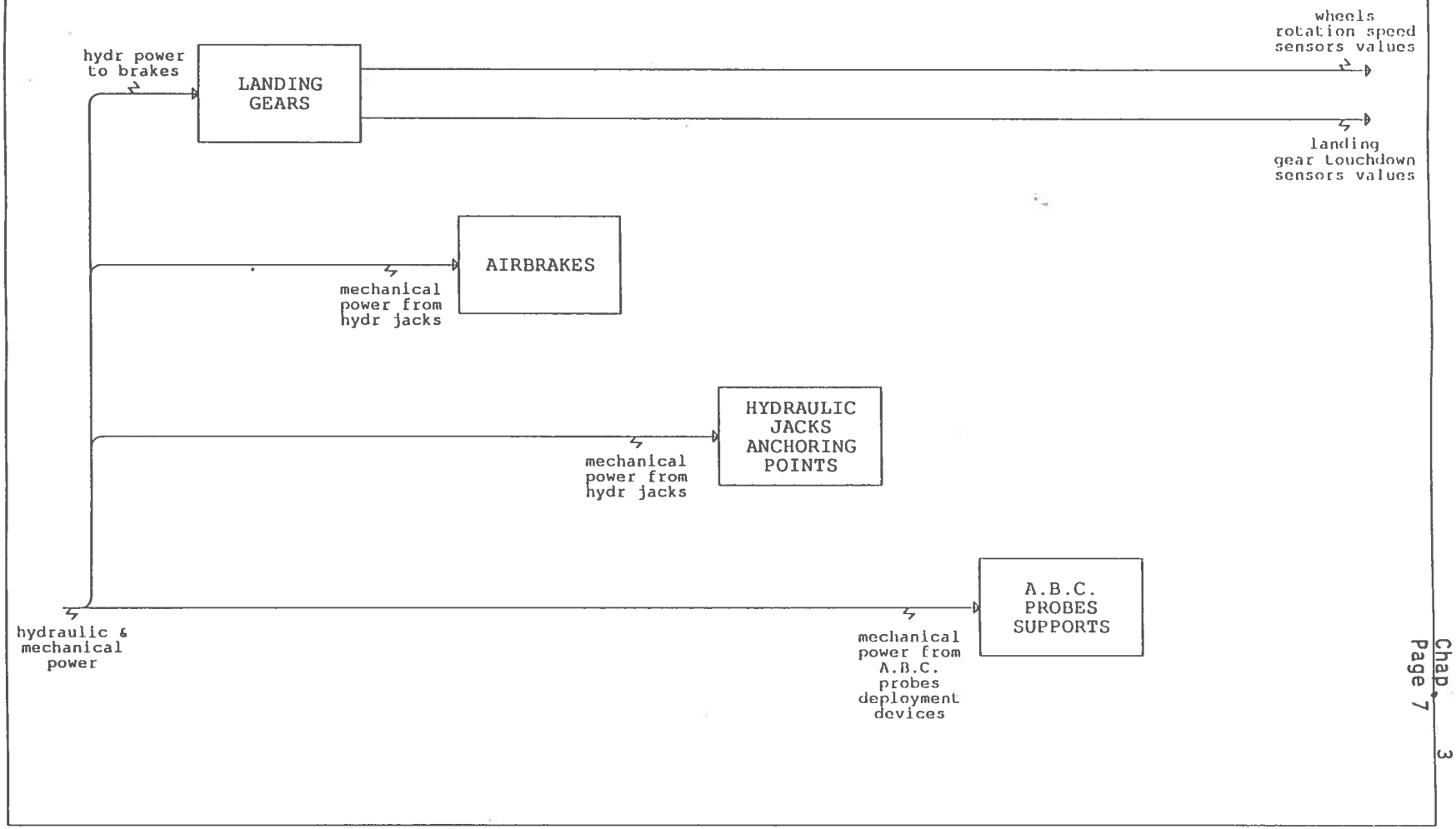
AIRFRAME	R6	
		Page



b) Functions specific to FCS