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Development of the Resource Module for the European Space Station Programme Columbus

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DEVELOPMENT OF THE RESOURCE MODULE FOR THE EUROPEAN SPACE STATION PROGRAMME C O L U M B U S

This presentation summarizes the evolution of a resource module during the study phases B1 and B2 from July 1985 to May 1987.

The development has been performed by Dornier System on behalf of the European Space Agency ESA leading a consortium of 12 European companies. This summary shows the aim of establishing a design concept supposed to be most flexible with respect to changing mission scenarios as well as different applications of the module. The presentation also shows the development of the design itself with emphasis on the present reference configuration.

At the beginning of phase B1 only one European Pressurized Module was thought of. This module was supposed to be launched by NSTS and should be prepared for operation at the US Space Station (USSS).Only when the full performance of the operation of the Pressurized Module is verified the Resource Module would be launched by another shuttle flight. The connection of the Resource Module and the Pressurized Module, however, should also be done at the USSS. The free-flying phase would then start after successful connection of both modules at first. During this phase the scientists would be able to take maximum advantage of undisturbed environments for all micro-g experiments. After several weeks or months, and being back at the station, maximum use

could be taken out of the service of a constantly manned station. During such a period of exchanging, changing, tuning, etc of experiments the Resource Module was planned to be used to perform a free-flying mode with payload carriers in a coorbiting environment.

At that time the RM design was governed by the requirement of a 10 Kw payload power and a 30 year life time based on in-orbit replaceable units (ORUs). The first design concept developed is shown in Fig 1.

Fig 2 shows the RM design after the first design optimization step covering the following items:

- Reduction of mass and volume by high density ORU packaging: Change from box type ORUs attached onto the main body to PC-board type ORUs slid into a double-H structure as shown in Fig 3.

- Simplification of solar array deployment: Change from multiple to single deployment mechanisms by using telescope booms.

- Increase of deployable thermal radiators for rejection of all generated heat.

Fig 4 shows above Resource Module in a coorbiting platform mission after on-orbit exchange of PM with a coorbiting payload carrier.

In April 1986 major requirements were changed:

- **MTFF:** Change from a timeshared 4-segment PM to a dedicated 2-segment PM, now dedicated to MTFF usage

- **COORBITING PLATFORM:** Time shared used of RM for a coorbiting platform replaced by Eureca type coorbiting platforms, independent of RM

- **PAYLOAD POWER:** Reduction from 10 Kw to 5 Kw

- **RM/PM INTERFACE:** Change from automatic docking port to an EVA separable interface adaptor

- **LAUNCH:** The MTFF configuration, including 2 tons payload, is to be a single shot Ariane 5 launch.

The RM configuration in response to above requirement changes is shown in Figures 5 and 6.

It was already at the end of phase B1 that the possible application of the RM of the MTFF for the Polar Platform was investigated with only slight modifications (see Figures 7 and 8).

This exercise was initiated by ESA to investigate maximum possible commonality of the required resources for the coorbiting Man Tended Free Flyer and the polar orbiting platform despite the different orbit and payload requirements. It is clear that a single development, a single

qualification, and single spares will be more economic than separate developments. This is even true in most cases if one side takes advantage of some features which are not required completely for their application. This investigation was carried out on different buildup levels, such as equipment, orbit replaceable units, and full system level and it was also performed for each subsystem. The final result showed that the efficiency of commonality increases together with the buildup level. With reasonable requirement adaptations the commonality can be brought up to a level of more than 80 %.

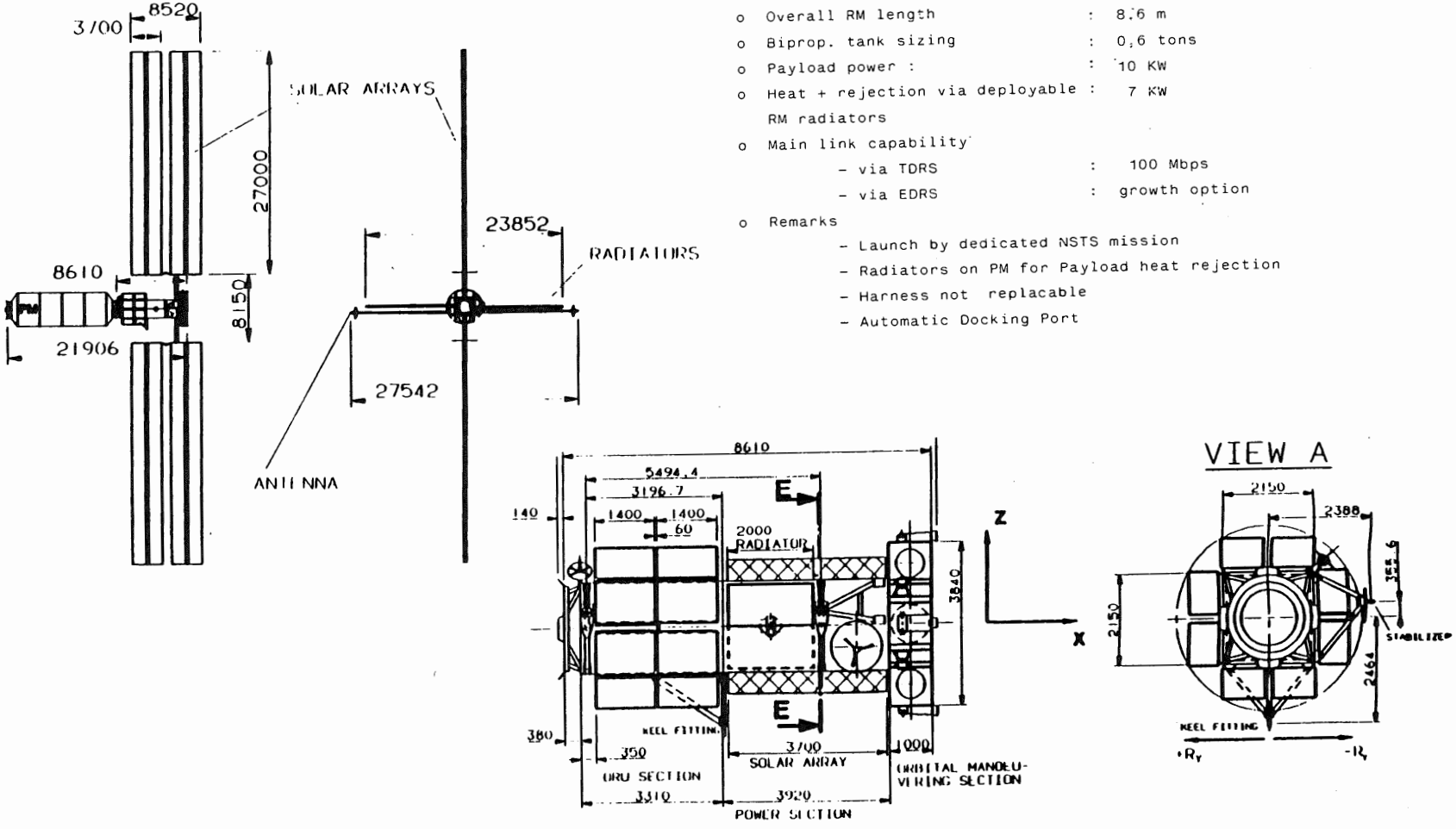
Figures 9 and 10 show the application of a common Resource Module for MTFF and PPF based on the present reference configuration.

In parallel to this development Dornier System performed other special studies for ESA and the German government, viz the investigation of a possible application of the Man Tended Free Flyer and the Resource Module for a growing European Space Station (Figures 11 to 13).

Fig 14 shows a specific Resource Module concept based on the same design concept, which allows access to the Pressurized Module via a tunnel.

Such a design concept would give additional flexibility in building up a full station. It can be seen that the basic design concept of the Resource Module will still be kept up. Thus, even by taking both concepts for different applications the commonality effect would be optimized.

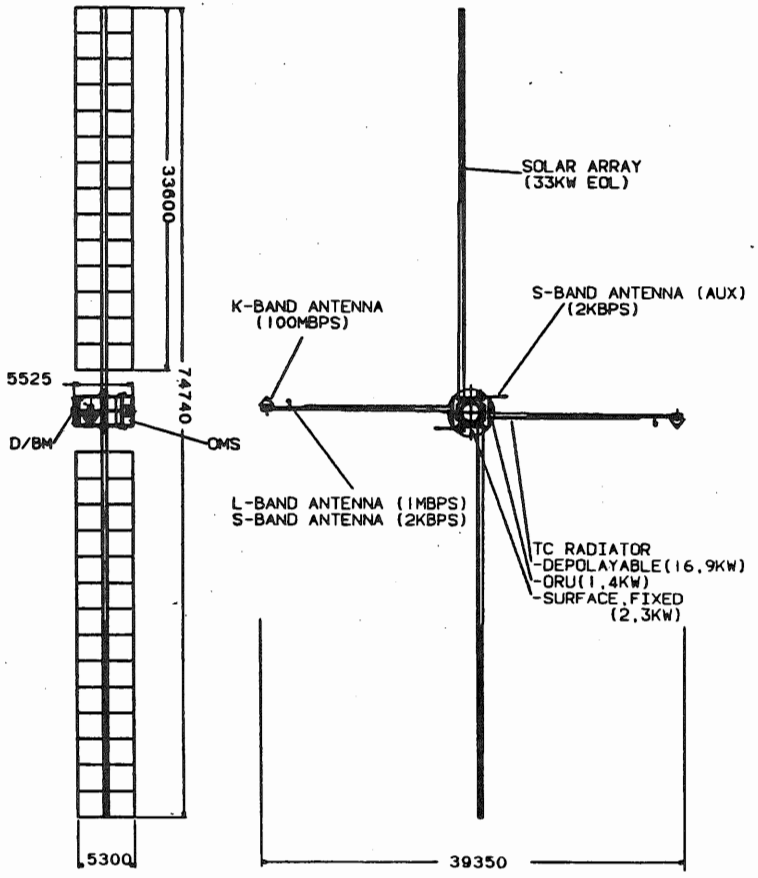
The evolution of the space station and the adaptation to different scenarios will still continue into the near future. But, as shown before, eventhough the design concept is 'frozen' by definition reasonable modifications can still be implemented and adapted. It is more important to continue the detailing of the reference configuration in parallel to the overall and general scenario evolution.



- o Overall RM dry mass : 9,3 tons
- o Overall RM length : 8.6 m
- o Biprop. tank sizing : 0,6 tons
- o Payload power : : 10 KW
- o Heat + rejection via deployable : 7 KW
  RM radiators
- o Main link capability
  - via TDRS : 100 Mbps
  - via EDRS : growth option
- o Remarks
  - Launch by dedicated NSTS mission
  - Radiators on PM for Payload heat rejection
  - Harness not replacable
  - Automatic Docking Port

Figure 1 : RM Configuration of beginning Phase B1

- o Overall RM dry mass : 6,8 tons
- o Overall RM length : 5,5 m
- o Biprop. tank sizing : 1,6 tons
- o Payload power : 10 KW
- o Heat rejection via deployable RM radiators : 21 KW
- o Main link capability
  - via TDRS : 100 Mbps
  - via EDRS : growth option
- o Remarks
  - Launch by dedicated NSTS mission
  - no radiators required on PM
  - Harness not replacable
  - Automatic Docking Port



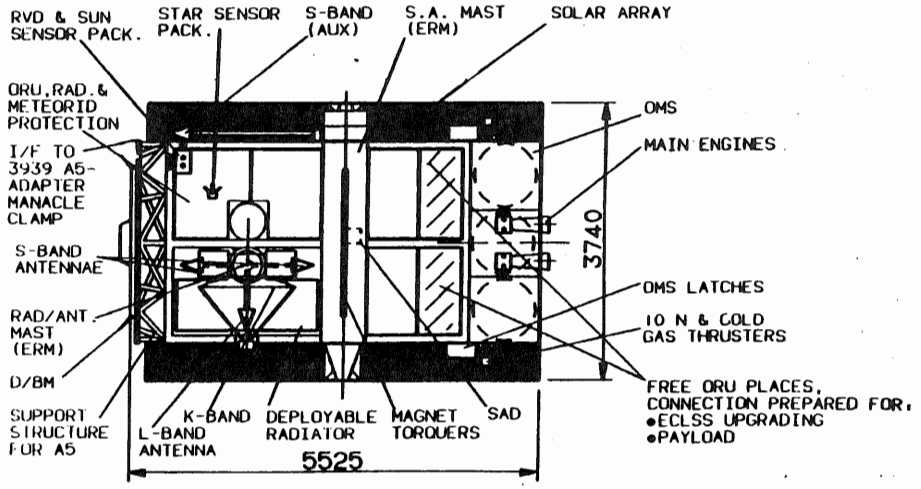
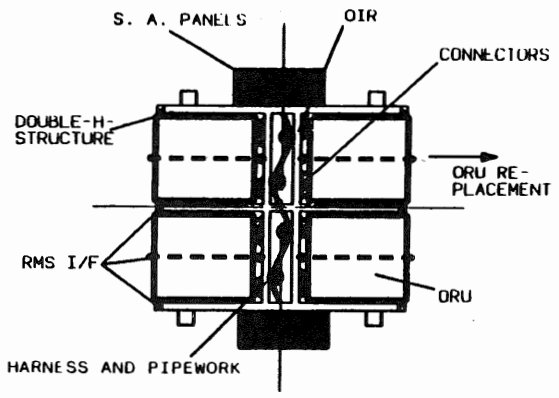
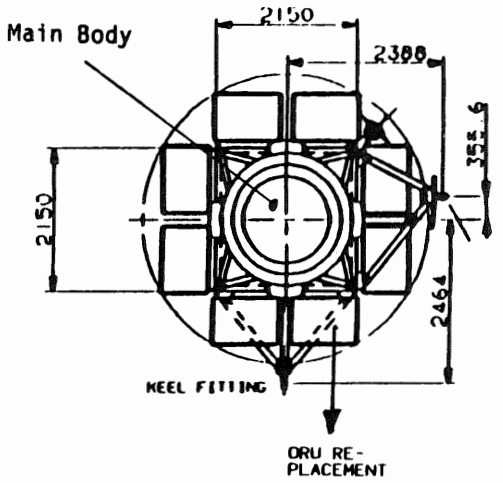


Figure 2 : RM Configuration after first optimization step – Phase B1/SR3



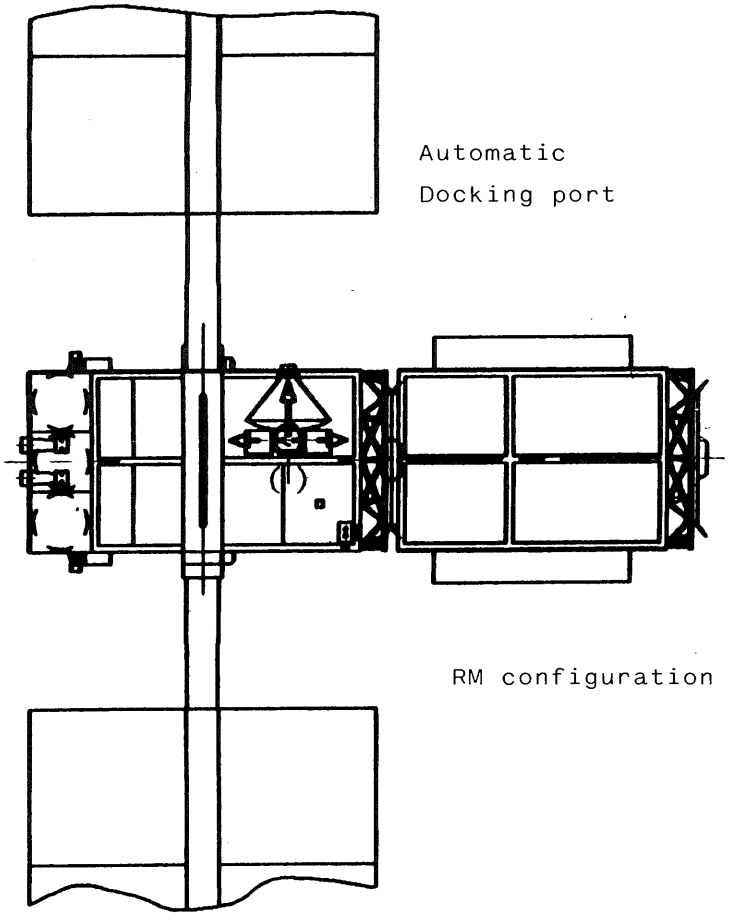


PC - Board Type ORU
- o high packing density
- o easy replacement due to long guiding rails
- o ORU structure consists of one baseplate and one cover

Box - Type ORU
- o not usable volume in main body
- o more complex replacement
- o ORU structure consists of one baseplate and 6 covers

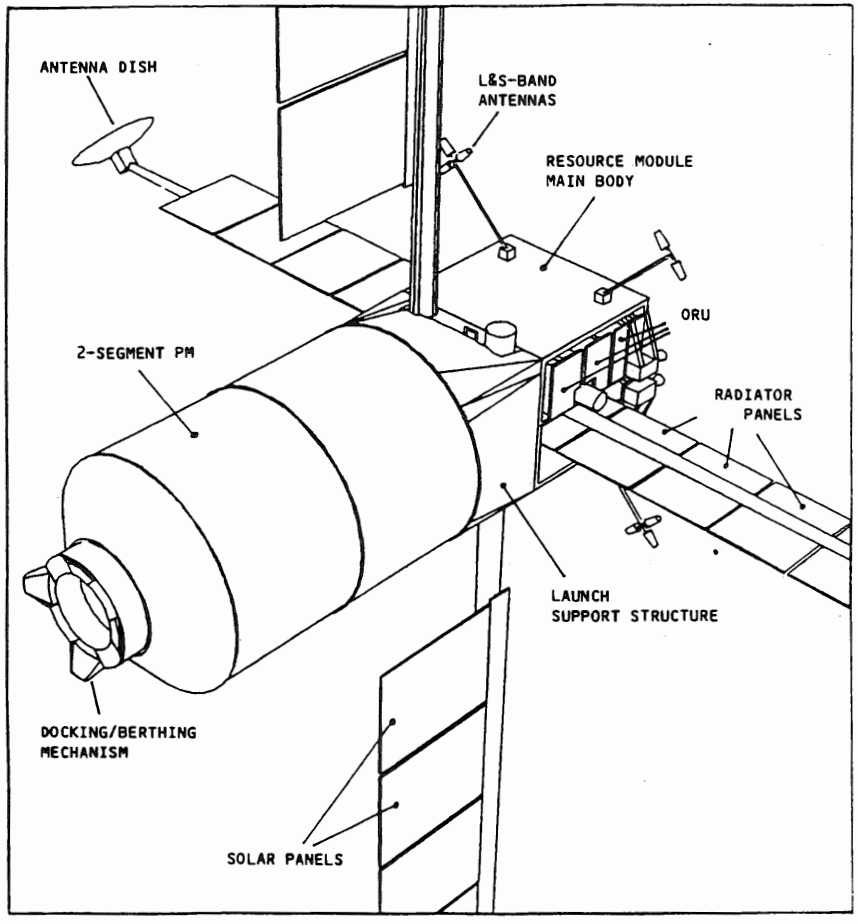
Figure 3 : ORU Concepts

RM assumed to be used
time - shared for :
- MTFF with PM4
- CPF with PC



RM configuration status - Phase B1/SR3

Figure 4 : Coorbiting Platform with RM and Payload Carrier



- o Overall RM dry mass : 4,3 tons
- o Overall RM length : 3,3 m
- o Biprop. tank sizing : 0,5 tons
- o Payload Power : 10 KW
- o Heat rejection via deployable RM radiators : 11 KW
- o Main link capability
  - via TDRS : 100 Mbps
  - via EDRS : growth options
- o Remarks
  - Launch together with PM by A5
  - Main servicing at USSS, Hermes as back-up
  - No radiators required on PM
  - Harness replacable on orbit
  - EVA separable RM/PM interface sized for single A5 launch

Figure 5 : RM B1 Reference Configuration in response to requirements changes

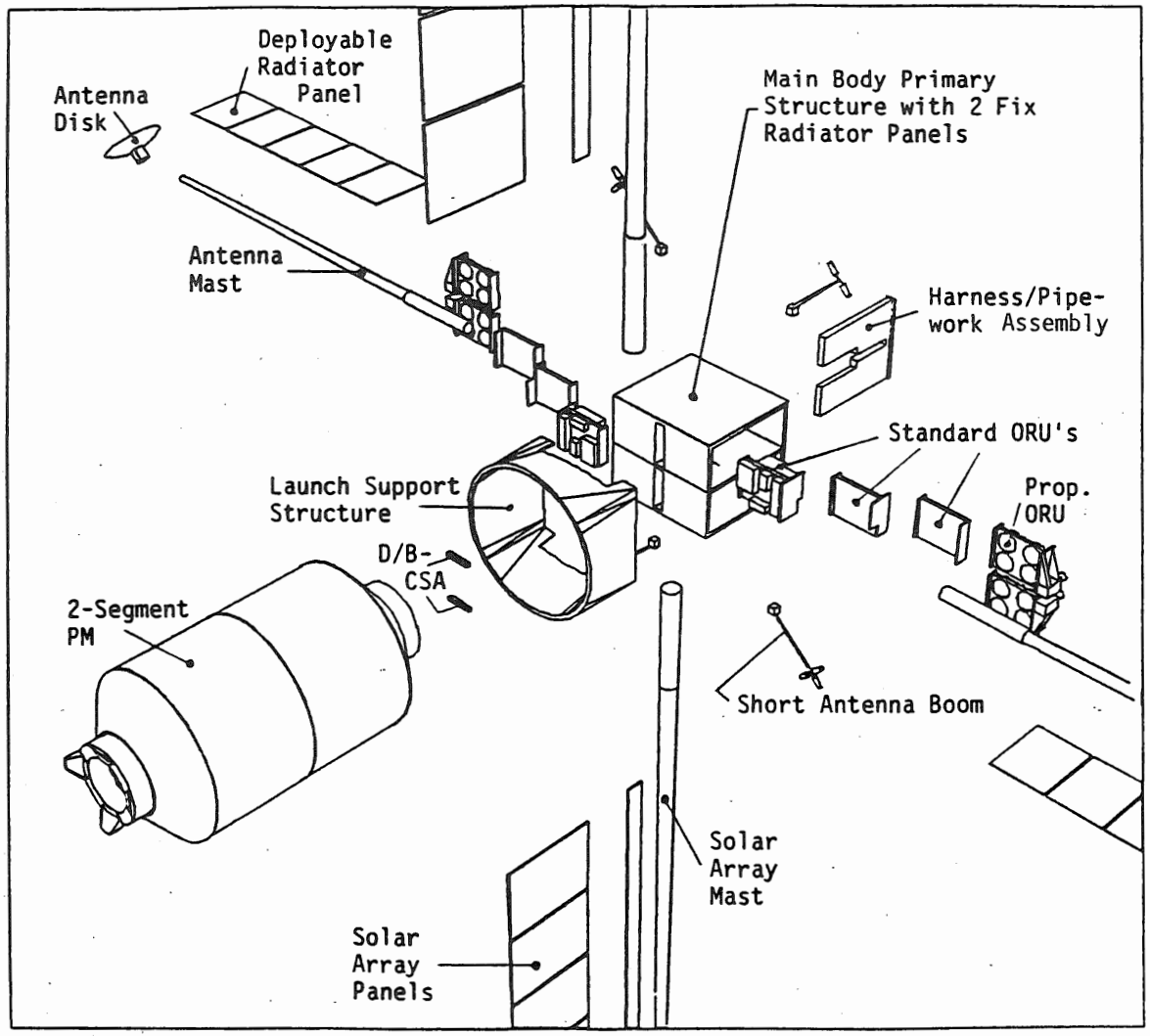
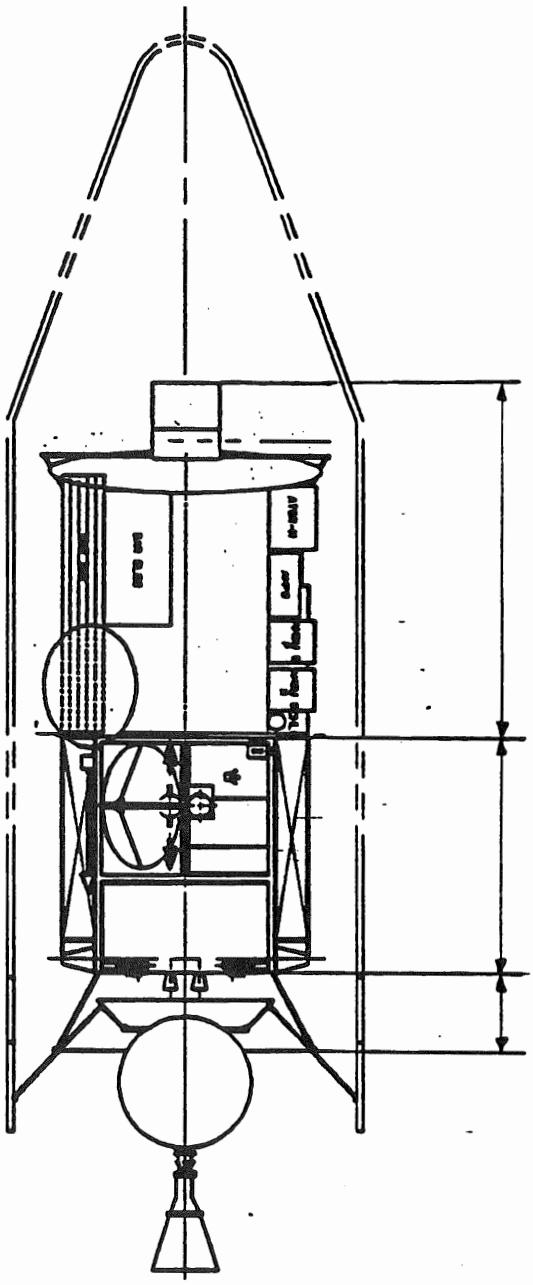


Figure 6 :

RM B1 Reference Configuration in response to requirements changes



o Main Modifications
- increased bipropellant tanks
- modified solar arrays

Figure 7 : RM B1 Reference Configuration
- modified for PPF

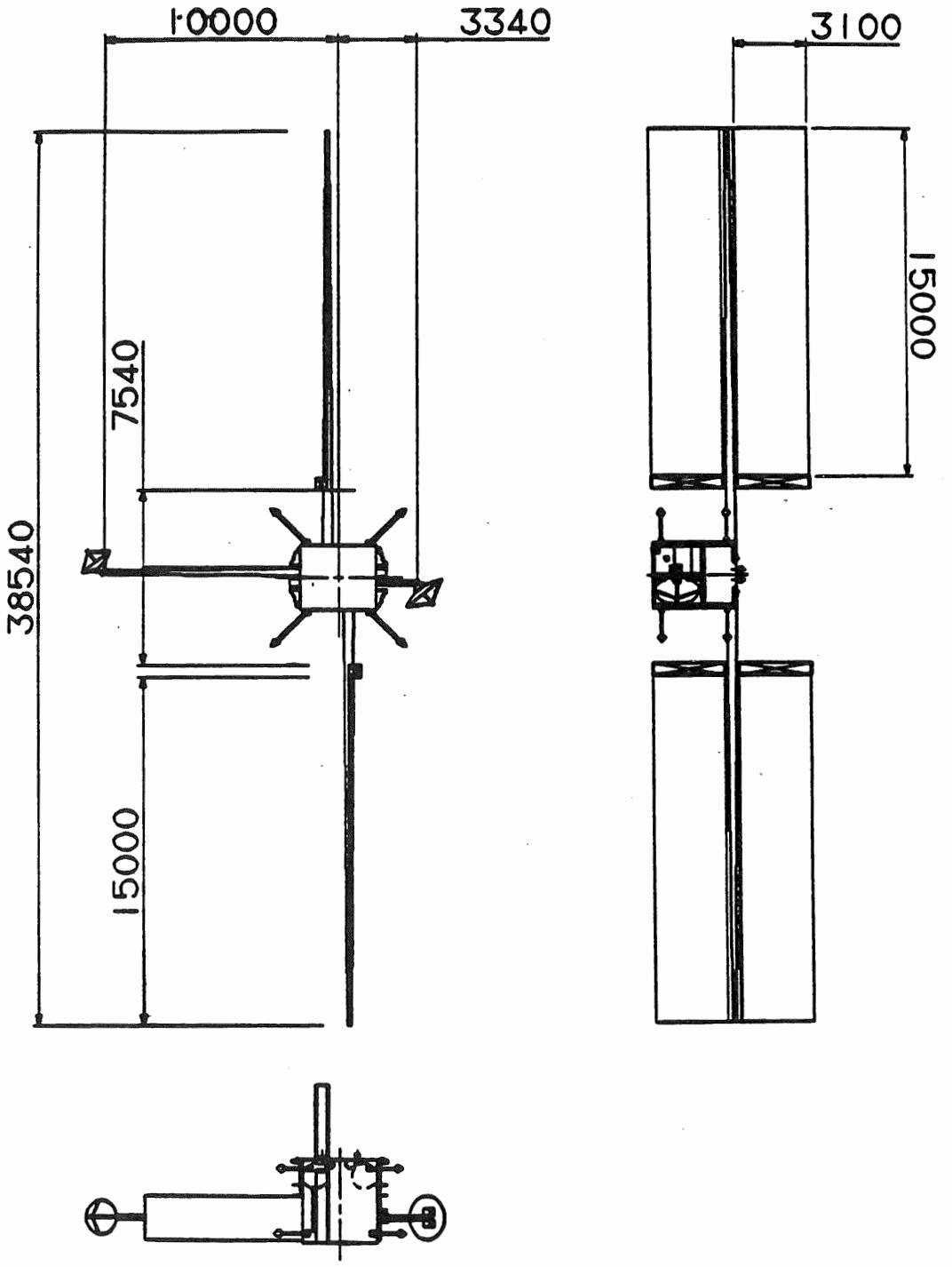
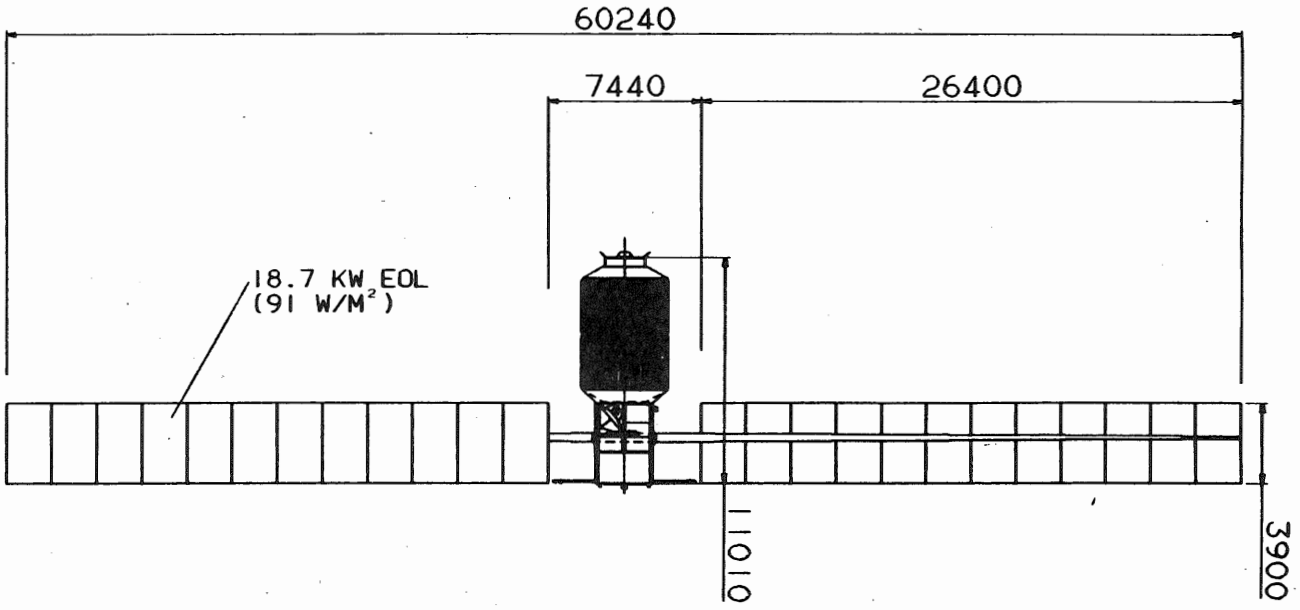


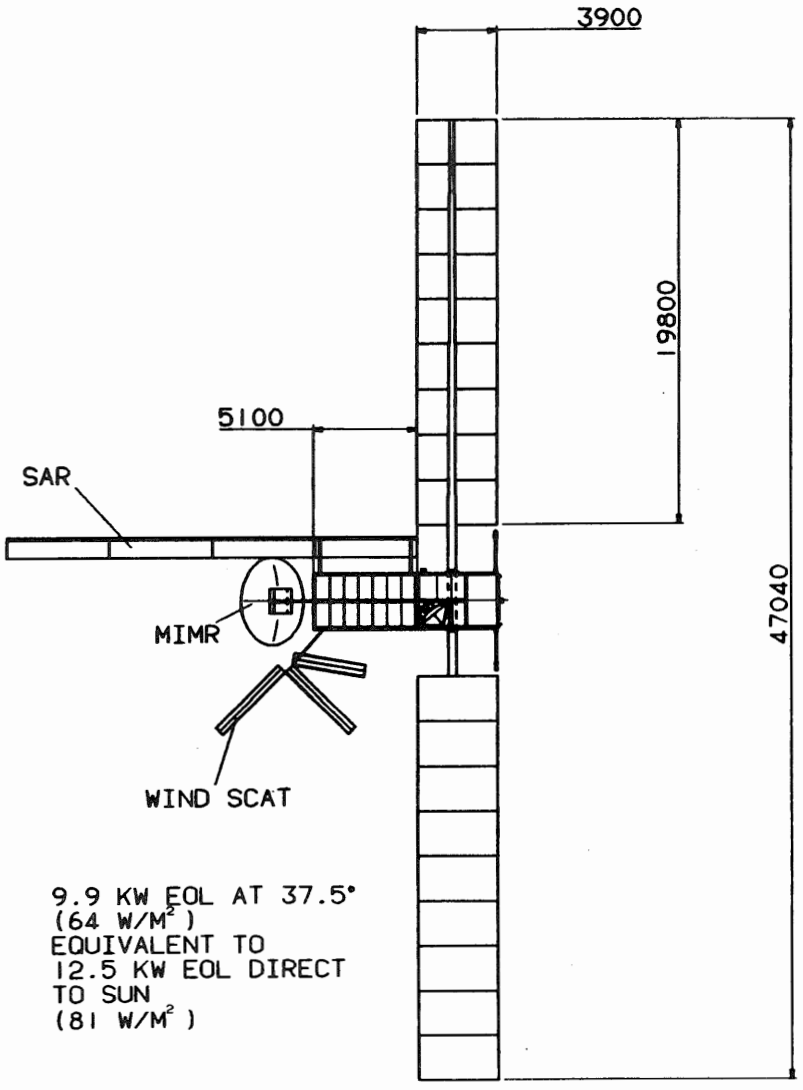
Figure 8 : RM B1 Reference Configuration
- modified for PPF



- o Overall RM dry mass : 4,5 tons
- o Overall RM length : 3,9 m
- o Biprop. tank sizing : 3,1 tons
- o Payload power : 5 KW
- o Heat rejection via body fixed RM radiators : 3,5 KW

- o Main Link Capability
  - via RDRS : 300 Mbps
  - via EDRS : 500 Mbps
- o Remarks
  - Launch together with PM by A5
  - Pure Hermes servicing feasible
  - Body fixed PM radiators required
  - Harness replacable on orbit
  - EVA separable RM/PM interface

Figure 9 : Present design of Common Core Module in its MTFF application



- o Overall RM dry mass : 4,2 tons
- o Overall RM length : 3,9 m
- o Biprop. tank sizing : 3,1 tons
- o Payload power : 3,1 KW
- o Heat rejection via body fixed RM radiators : 3,2 KW
- o Main Link Capability
  - via TDRS : 300 Mbps
  - via EDRS : 500 Mbps

- o Remarks
  - Launch together with PC by A5
  - NSTS servicing every 3 to 4 years (Hermes servicing not feasible)
  - Body fixed PC radiators required for PL heat rejection
  - Harness replacable on orbit
  - EVA separable RM/PC interface

Figure 10 : Present design of Common Core Module in its PPF application

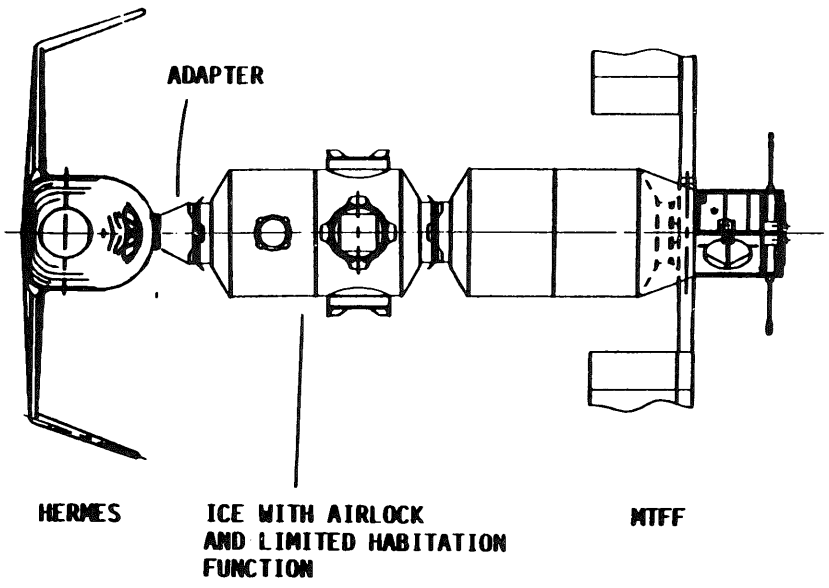


Figure 11 : First step into European Space Station by adding an Interconnecting Element to the MTFF

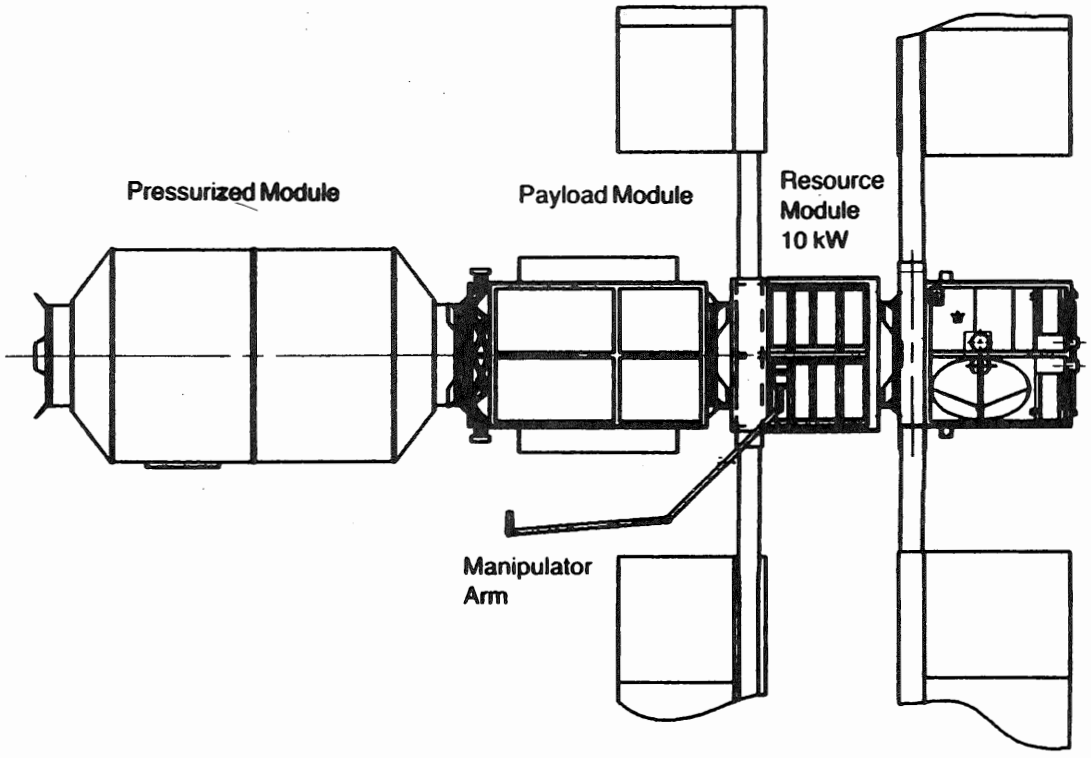


Figure 12 : RM refernce configuration with Power Add-On Section, unpressurized payload carrier and a two segment Pressurized Module

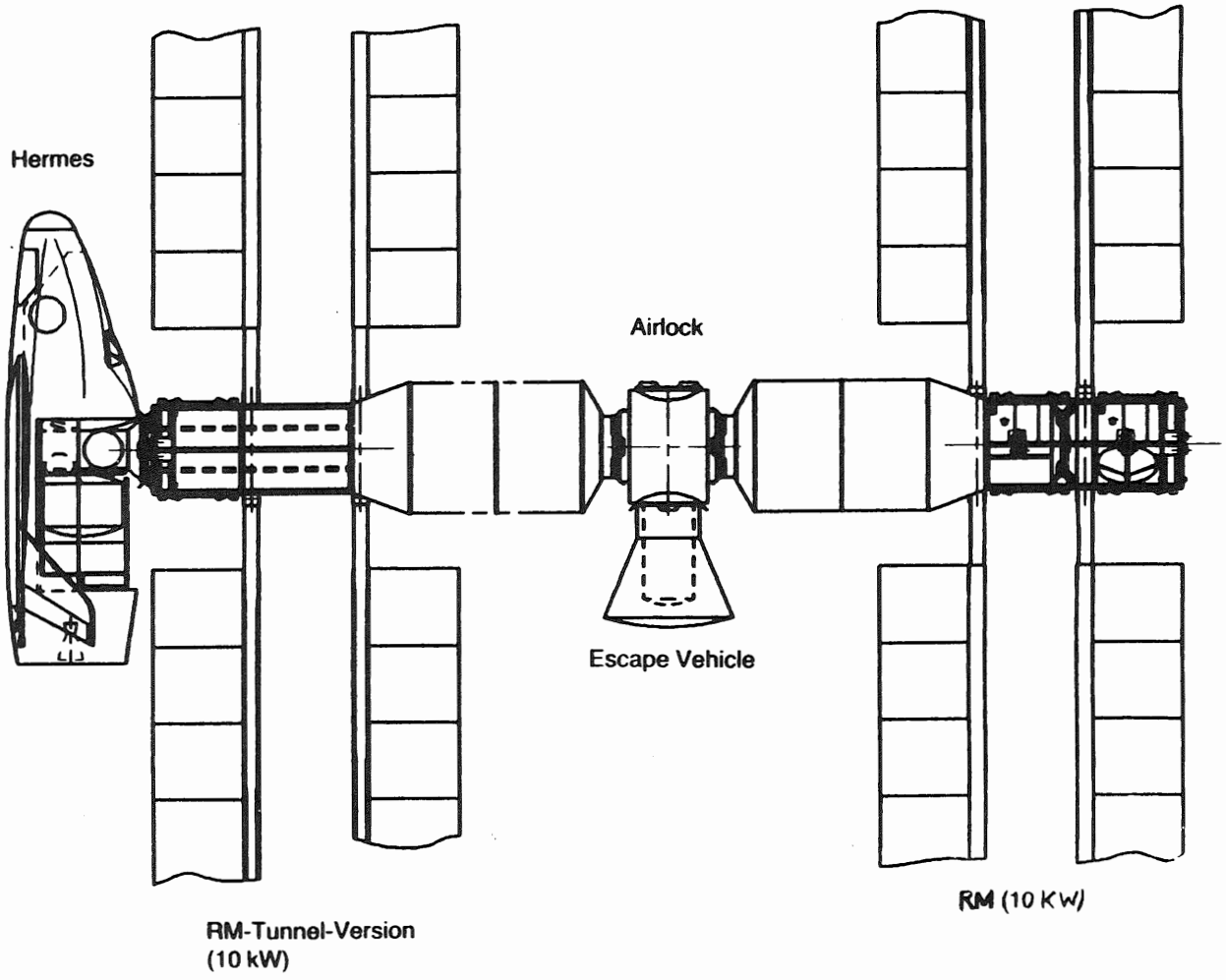


Figure 13 : Space Station Configuration utilizing RM referene design and RM "Tunnel - Version" (see figure 17)

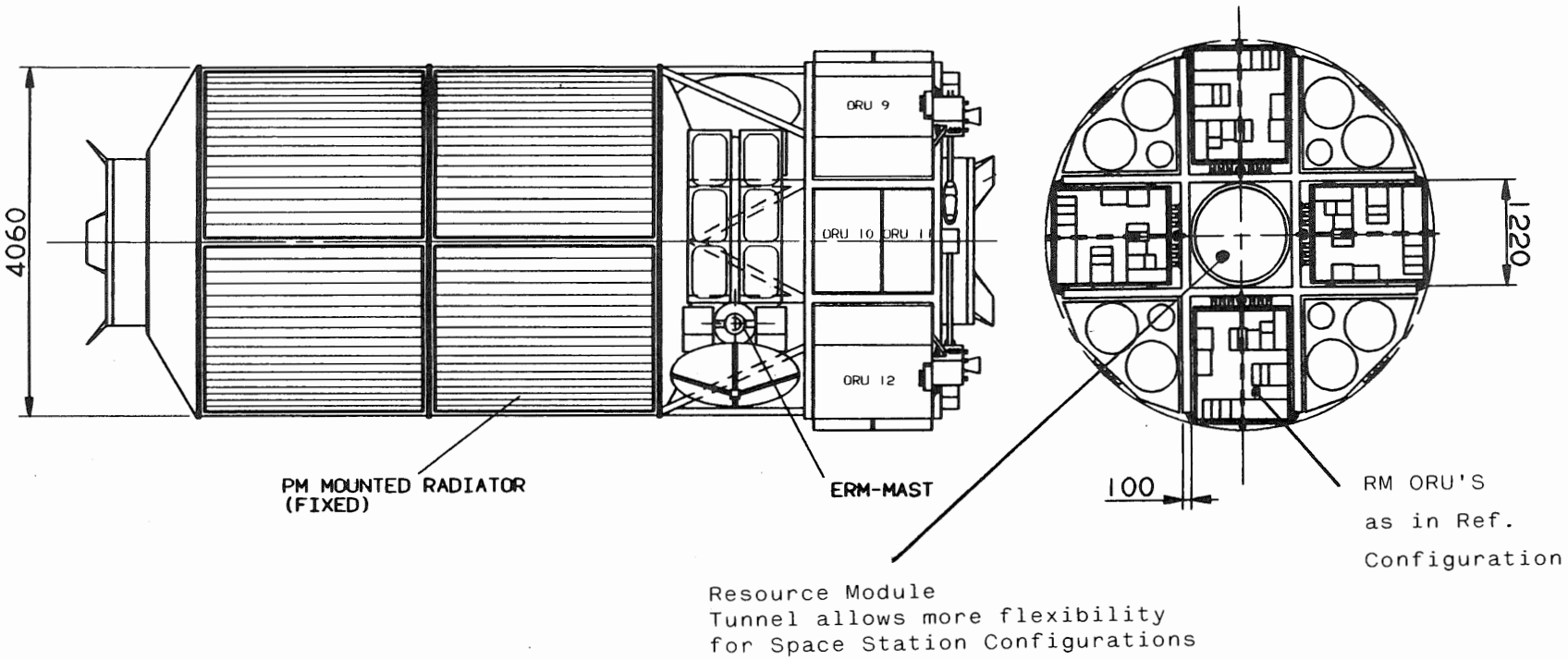


Figure 14 : Resource Module "Tunnel - Version" for Space Stations