# CONCEPT FOR A COMMERCIAL SPACE STATION LABORATORY

by

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## ABSTRACT

This paper examines the concept of a privately owned and operated fee-for-service laboratory as an element of a civil manned space station, envisioned as the venture of a group of private investors and an experienced laboratory operator to be undertaken with the cooperation of NASA. This group would acquire, outfit, activate, and operate the laboratory on a fee-for-service basis, providing laboratory services to commercial firms, universities, and government agencies, including NASA.

This concept has been developed by Booz, Allen and Hamilton with the assistance of Dr. Myron S. Weinberg, under contract to NASA to identify, stimulate, and assist potential commercial users of a manned space station.

This paper examines a number of the issues which would be related to the concept, including the terms under which NASA might consider permitting private ownership and operation of a major space station component, the policies with respect to international participation in the construction and use of the space station, the basis for charging users for services received from the space station, and the types of support that NASA might be willing to provide to assist private industry in carrying out such a venture.

The objective of such a venture would be to provide a commercially operated space research facility for use by both private and public organizations. It will also enable involving the private sector in the construction of a U.S. space station, and would contribute to assuring U.S. leadership in the commercialization of space.

## INTRODUCTION

Private sector interest and activity in space is beginning to accelerate in the wake of President Reagan's dual commitments to a permanently manned space station and the promotion of private sector investment in space, both of which figured prominently in his State of the Union address of January 25, 1984. The President singled out the Space Station initiative in a subsequent radio speech, and in a line item in his Fiscal Year 1985 budget sent to the Congress on February 1. If this new level of interest is to be sustained and converted into commercial manufacturing in space, the ability to conduct research and development in space must be improved.

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With the high cost of space research facilities and equipment, few companies can afford to start their own R&D programs from scratch; instead they must develop cooperative arrangements with NASA through which they can use or modify existing pieces of equipment or jointly develop new ones. While in the short run this is probably the most effective approach for accomplishing commercial R&D, ultimately the private sector cannot and should not rely on the government for such support.

On the ground, similar private sector needs for facilities beyond those of any one company are met by commercial laboratories. These laboratories are equipped and staffed to conduct highly responsive short and long term research for their clients – both individual companies and government agencies – in a wide range of disciplines.

The concept of a commercial laboratory as an element of a manned Space Station is directly analogous to such a ground-based commercial laboratory. Operating long term in a microgravity space environment, such a laboratory would be well suited to the needs of many private sector companies to conduct research on phenomenology, processes, materials, and products as influenced by the attributes of the space environment.

This paper addresses the concept of the Commercial Space Station Laboratory (CSSL) in terms of:

- How it originated and why it is being considered
- Its possible configuration and features
- How it relates to the proposed space station
- How it would operate
- The issues to be addressed
- The current status of the CSSL concept.

## WHY A COMMERCIAL SPACE STATION LABORATORY?

Man in space is turning the corner to a new era. The last twenty-five years have seen remarkable technological achievements, and extensive exploration – of the moon and most of the planets of our solar system. Now we are planning to develop the return on the investment which has gained our access to space. Already a thriving satellite communications industry, measured in billions of dollars, has been established. The next significant commercial step is expected to be the start of a material processing in space (MPS) industry.

President Reagan's State of the Union address of January 25, announcing his Space Station initiative and support of the commercial use of space has stimulated further interest in MPS. But each space product and process will depend on considerable research and testing before production can be undertaken. The space shuttle and the Spacelab carried in its cargo bay provide today's facility for conducting such research and testing in space, subject to the limitations of capacity and mission duration, measured in days. When the Space Station is deployed, in the early 1990's, it will include a laboratory enabling more extensive lab work on a long term basis.

During the Space Station user development work carried out for NASA by Booz, Allen & Hamilton, in which numerous non-aerospace companies were contacted, a number of companies were found to be reluctant to invest in hardware to conduct product research, but

willing to spend substantial money if the research could be purchased as a service. Such observations, combined with the determination that NASA was willing to consider proposals for private investment in modules planned as elements of the Space Station, inspired Booz, Allen's concept for the Commercial Space Station Laboratory – the space equivalent of a ground-based commercial laboratory serving the needs of commercial and government customers. Private investment in CSSL would not only provide a unique capability to a wide range of customers, it would enhance the probability of successful completion and deployment of the Initial Operating Capability (IOC) manned Space Station, by reducing the requirement for appropriated acquisition funds.

## WHAT IS THE CSSL CONCEPT?

The CSSL concept, then, provides for a privately owned, operated, and staffed, fee-for-service laboratory – on orbit in a microgravity environment – as an element of the initial Space Station capability. It would be acquired and deployed by a group of private technical and financial partners. The lab would be configured and staffed for research and testing in such discipline areas as biology, pharmacology, crystal growth, organic and inorganic separations, specialty glasses, and metallurgy. It would focus on both processes and products, taking advantage of the ability to conduct extended series of experiments with rapid interpretation, adjustment of parameters, and reruns. Users would include private companies, universities, government agencies, foreign countries, industry associations, and even individual researchers.

A representative Space Station concept is illustrated in Figure 1, showing how the Commercial Space Station Laboratory might be attached to the Space Station Multiple Berthing Adaptor, allowing access to all necessary services, the habitation and logistics modules, and extra-vehicular activity. Figure 2 shows an enlarged view of the CSSL module. This and subsequent figures display the results of preliminary engineering work performed by Booz, Allen with the help of McDonnell Douglas Astronautics Company.

A number of different activities can be accommodated, as indicated in conceptual drawings. Figure 3 shows typical racks of equipment for materials processing. Biological and metal production equipment would be provided in additional racks, shown in Figures 4 and 5. Figure 6 shows the configuration of the 'back porch' – an unpressurized pallet designed to be attached to the free end of the pressurized laboratory module to carry equipment which need not be pressurized, saving internal volume, and accommodating experiments operating in vacuum. As the need for other types of laboratory work develops, the lab can be reconfigured, in most cases without returning it to the ground. When demand projections support expansion, additional modules would be provided to the IOC Space Station or to the second Space Station.

## HOW DOES CSSL RELATE TO SPACE STATION?

The Commercial Space Station Laboratory would be an attached, manned, pressurized module of the Space Station, probably mated to a multi-ported docking adapter as shown in Figure 1. It would, in effect, be a tenant of the host Space Station, much like a tenant business in an industrial park on the ground, obtaining services from the host. The Space Station would thus provide electrical power, life support, communications and data handling services, logistics and storage, hotel services, and crew support (such as recreation and exercise) in addition to maintaining orbit and orientation, and the means for docking with the STS orbiter on resupply missions.

Accordingly, a key step is the negotiation of an appropriate agreement between the parties – NASA (or whoever operates the Space Station), and the commercial venture operating the CSSL.

The CSSL operation could be achieved in any of several ways:

- The lab – including the pressurized module and all installed or attached equipment – could be procured, owned, and operated by the venture. In this case the module could be fabricated to the same specifications as the government-owned modules and might well be built by the same contractor, possibly under an option to the government contract.

- The basic module might be provided by the government and sold to the lab venture for fitting out and operations.

- The module might be leased to the operator.

- The module and equipment might be government owned and leased to the operator.

The first, or "All-Up", arrangement is the basic concept being explored. It requires the largest investment (and risks), but offers the largest return (through revenues, investment credits, and depreciation), and the most responsive service to customers through full proprietor control of configuration and outfitting.

## HOW DOES THE CSSL ENTERPRISE OPERATE?

Individual customers purchase or contract for services with the CSSL operator, either on a project or task-by-task basis, or on a longer term task order or program. Services might involve: producing samples of material under various parametric conditions for testing or sample use in space or on the ground; testing samples in the space environment; testing operations of prototypes, hardware, or other equipment on specific materials in the space environment; developing and testing proposed processes; and conducting separations to isolate target substances.

The CSSL operator pays NASA (or the Space Station operator) for utilities, communications, data handling, accommodations, life support, and condominium charges related to an orbit tenancy. The CSSL operator pays the space transportation system operator for transportation of the lab crews, visiting researchers, supplies, samples and product return, and equipment for reconfiguration or depot level maintenance.

The CSSL operator plans and provides all lab-peculiar life cycle support, staffing, and staff training. NASA will probably certify staff for service on orbit, and review standards of training. NASA will provide training for Space Station emergency procedures.

## WHAT ARE THE ISSUES?

One clear issue which must be studied is that of the size and type of market which may exist for the services of a Space Station laboratory by the time one can be made available.

Booz, Allen's commercial user development work for NASA has produced indications that interest in such activities exists, and NASA has encouraged Booz, Allen to pursue the concept with private investors and laboratory operators. Before detailed planning can proceed, however, a detailed market analysis must be conducted, both to determine the size of the market and the type of facilities that would be necessary, and to identify potential customers. Some of the interest which has been expressed has come from firms who would not have the resources to design and build complete space experiments, but would be capable of funding specific research if a properly equipped laboratory were available. As access to space improves and its cost is reduced, additional interest will be generated, and the CSSL will represent the most cost-effective way of pursuing that interest.

Another issue will be that of exclusivity – meaning whether there will be other laboratory facilities on the station, and who will be operating them. If NASA or some other entity will be in competition with the CSSL, it could reduce the potential profitability and savings to the government which CSSL would make available.

Related to this is the question of the basis on which NASA will charge tenants for the services that the Space Station will be providing to the CSSL. Until this policy is known, it will be difficult to estimate those costs and hence completely understand the economics of CSSL operations.

The issue of how international participation in the Space Station program will be handled may have a significant effect on how (or whether) a CSSL is possible. If the European space community, in the wake of its successful Spacelab effort, provides a major portion of the laboratory facilities, the opportunity for commercial ownership and operation of the laboratory could be preempted. The decision on international participation will also be affected by the degree to which the United States wishes to limit technology transfer in the construction of the Space Station, cast against the desire to incorporate extensive international cooperation in the program.

In addition, the questions of how to coordinate the private sector development of the CSSL with NASA's development of the Space Station, the need to reduce the time between the major investments and the beginning of revenue production, the tradeoff of investment and risk between NASA and the investors, and even the question of how the Space Station will be configured, will have a significant effect on the way that the CSSL concept can be developed.

## WHAT IS THE STATUS OF CSSL?

NASA has repeatedly expressed its interest in incorporating private sector activities in its Space Station program, and NASA Administrator James Beggs stated in the NASA budget briefing (January 31, 1984) that the Agency would be willing to incorporate private sector investment in a module in its program planning. With this indication of interest from NASA, one of the next steps will be to arrange a meeting of interested private sector investors with NASA officials to examine the process through which such an investment should be made.

In parallel with these next steps, the analysis of the issues identified above must be carried out, and alternative means of structuring an agreement with NASA must be drafted and examined. Above all, it is important that interested private sector individuals and organizations

come forward and participate in the development of the concept, before Space Station plans are finalized.

## AN OPPORTUNITY FOR U.S. INDUSTRY

The Commercial Space Station Laboratory represents a significant opportunity for U.S. industry to convert this country's considerable investment in space technology into a position of leadership in the developing space frontier. If the American people are to reap the benefits of this new frontier, it is essential that the government encourage and support the private sector in bold ventures such as the Commercial Space Station Laboratory.

# MANNED SPACE STATION

FIGURE 1

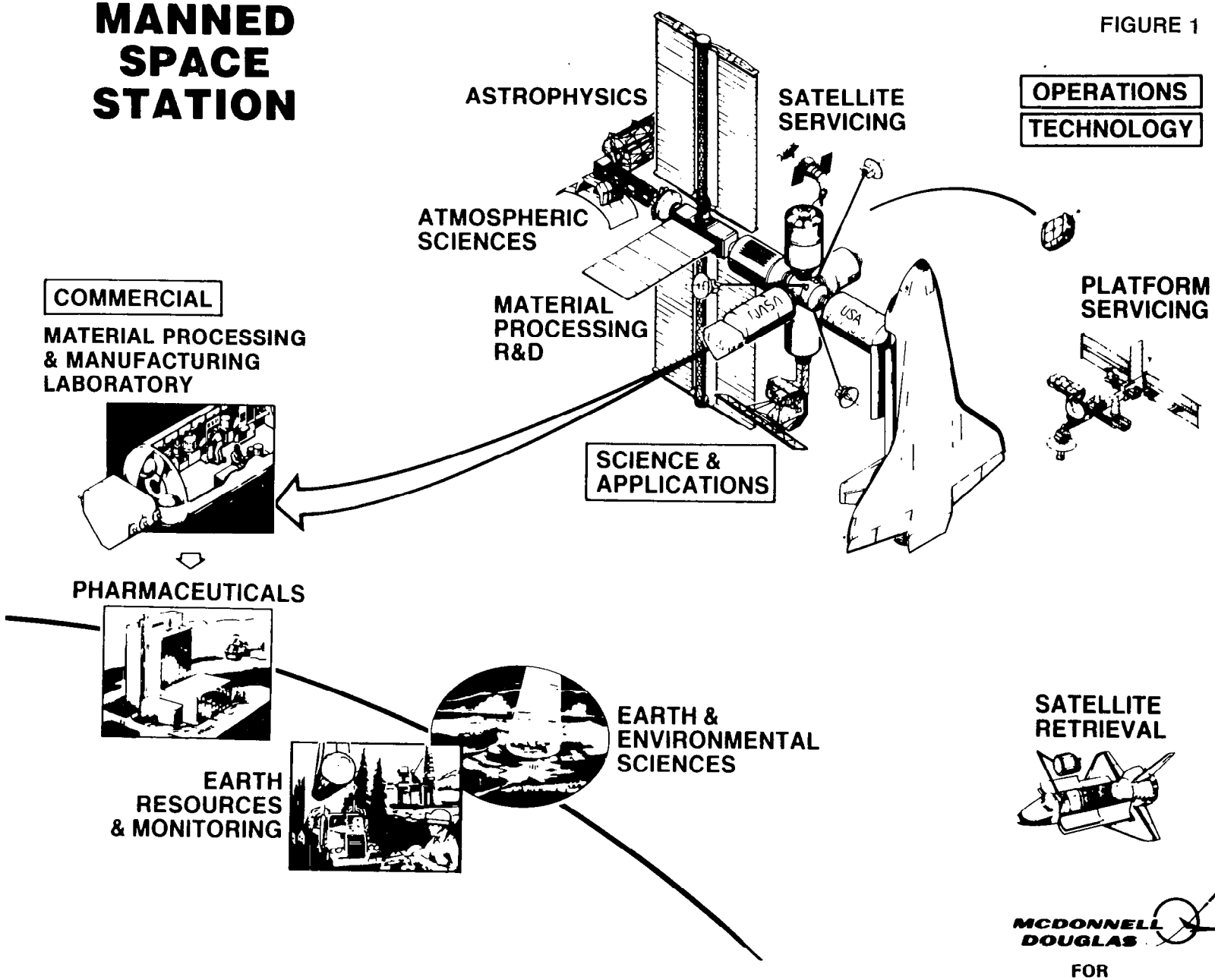


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FIGURE 2

# COMMERCIAL FEE-FOR-SERVICE LABORATORY

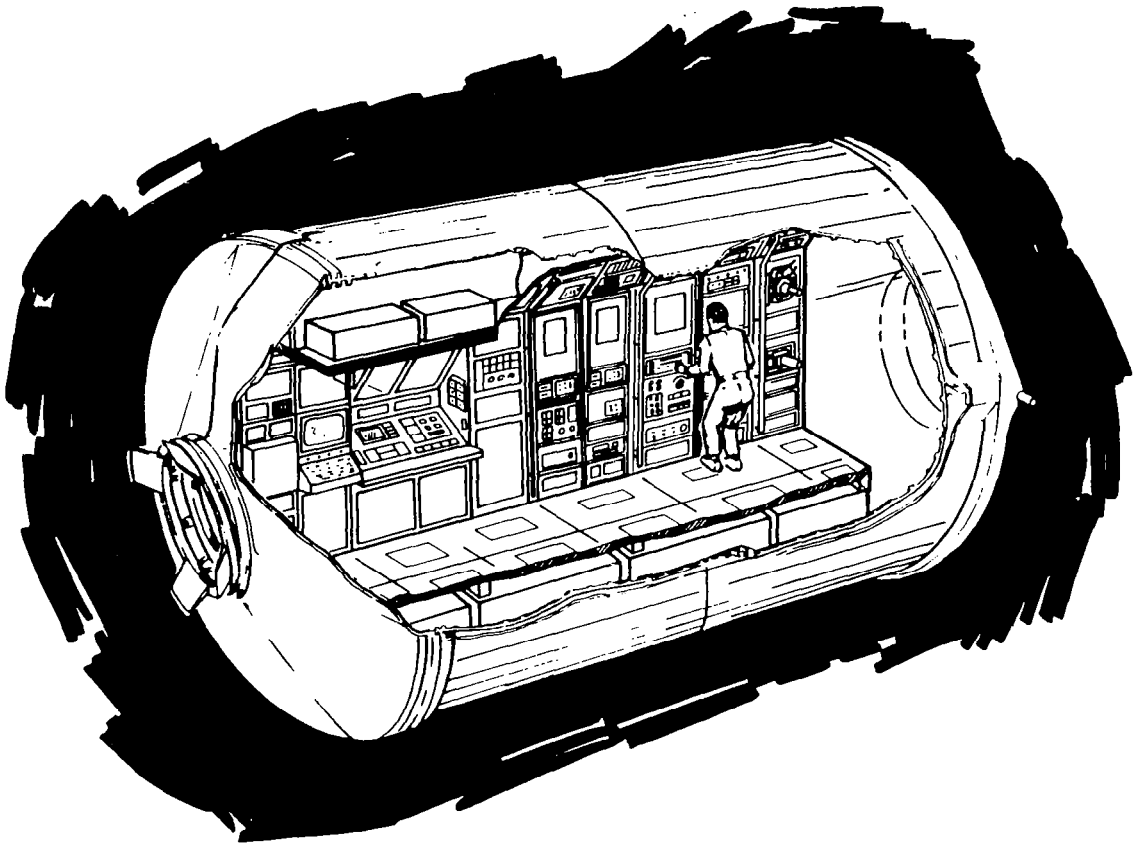


FIGURE 3

# TYPICAL MATERIAL PROCESSING EQUIPMENT INSTALLATION

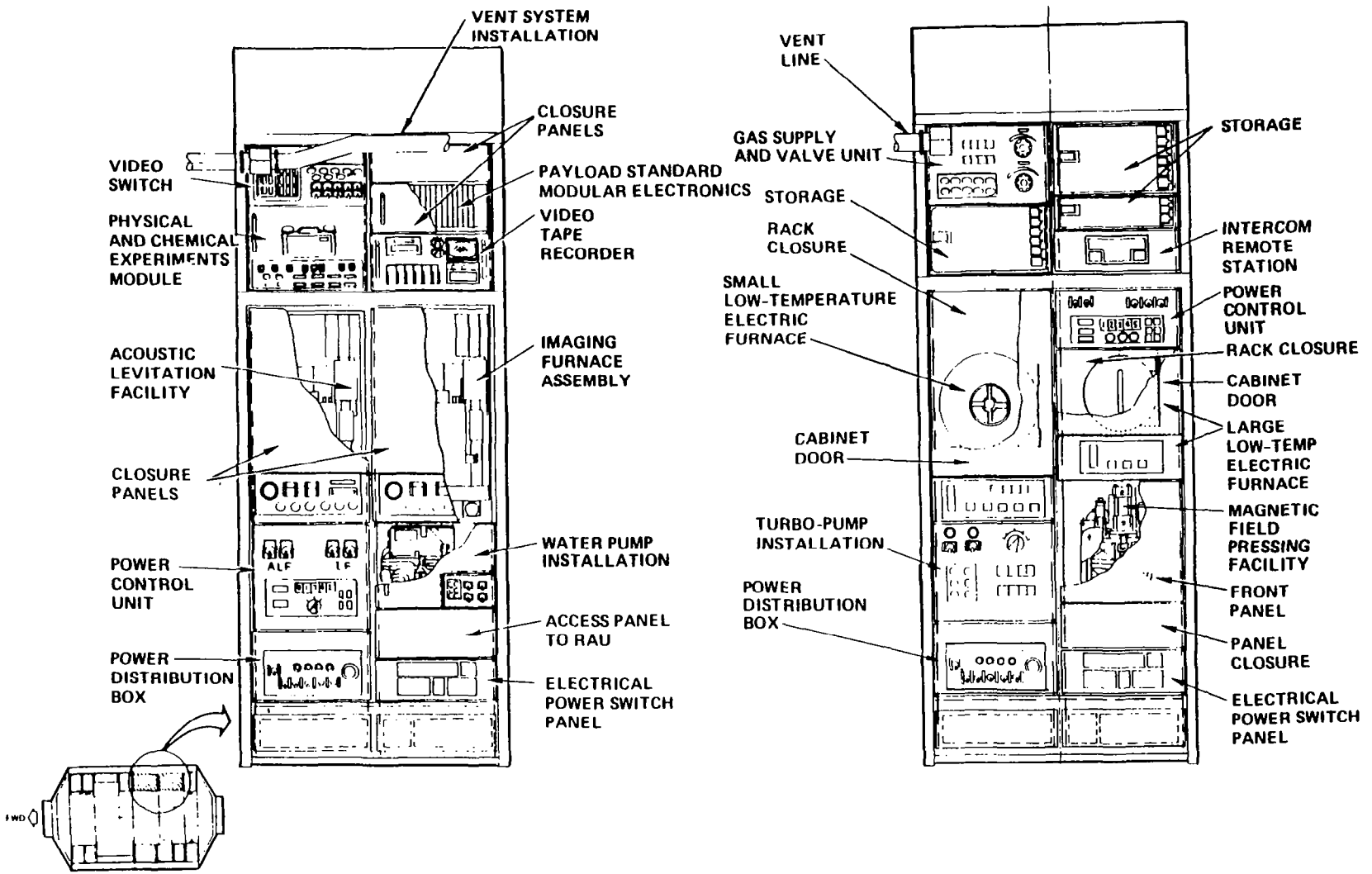
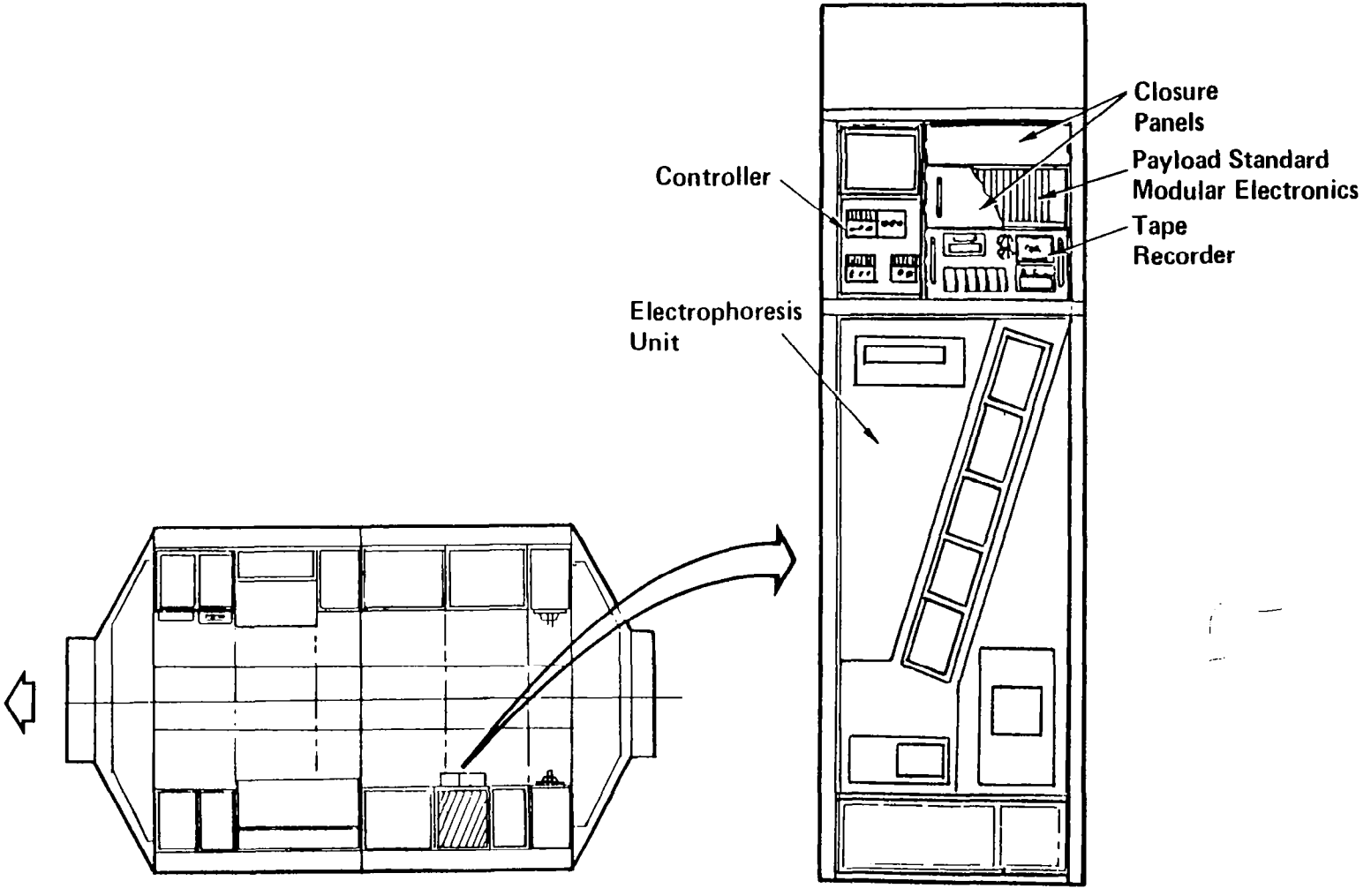


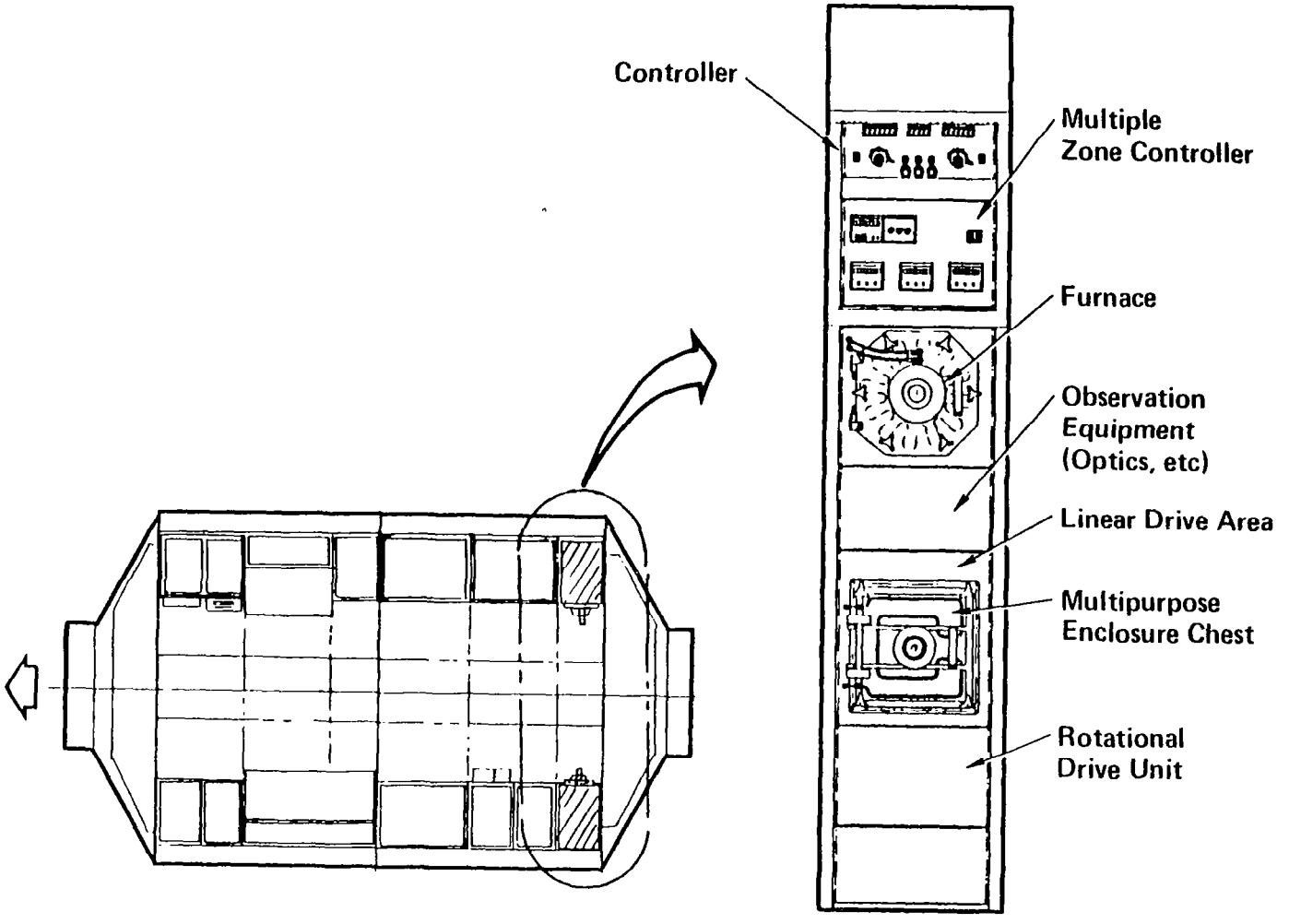
FIGURE 4

# TYPICAL BIOLOGICAL EXPERIMENT INSTALLATION



# TYPICAL METAL PRODUCTION EXPERIMENT EQUIPMENT

FIGURE 5



# COMMERCIAL LABORATORY - MATERIALS PROCESSING PALLET INSTALLATION

FIGURE 6