Table 2. Estimated Monthly Energy Consumption in the Old Ethnographic Storage

No. of Units	Equipment, Btu Rating	Watts	Hours	Days	Consumption (kWh)
1	Air cond. 30,000	3900	12	22	1029.60
1	Air cond. 30,000	3900	12	22	1029.60
1	Air cond. 30,000	3900	12	22	1029.60
1	Air cond. 14,000	2070	12	22	546.48
1	Air cond. 14,000	2070	12	22	546.48
22	Fluorescent light 40W	880	08	22	154.88
				Total	4336.64

NEW STORAGE FACILITY

In 2003, the MPEG gained a new storage space for the Amazonian ethnographic collection at its research campus at the edge of the city. It is located in a typical single-story contemporary urban building and consists of three rooms used for: (1) reception, quarantine and conservation treatments; (2) inventory and study of collections; and (3) the storage itself. The storage area measures 49 ft-3 in. × 59 ft (15 m × 18 m (270 m^2)), has a cement slab floor, a concrete slab ceiling of 9 ft-10 in. (3 m) high, and the walls are made of fired hollow bricks finished with cement plaster and white water-based paint. The roof is of corrugated metal sheets in two chutes, with a central air gap for passive ventilation of the attic space, with long eaves and a suitable surrounding drainage system.

Conceptual Design for Climate Control

The proposed climate control system for the new storage area consisted of sets of supply and exhaust ventilators and several portable mechanical dehumidifiers, and was to operate based on the output of relative humidity sensors located both inside and outside the buildings. The system was to operate only when the relative humidity rose higher than 70%—the threshold for microbial activities. The ventilators were to operate when the outside relative humidity was lower than the value to remove moisture, and the dehumidifiers were to activate when the outside relative humidity was higher than 70%. Therefore, the ventilators could not be used. It was decided to use mechanical dehumidifiers instead of heaters to reduce the rise of already high temperature and conserve energy. The approach would provide relative humidity control to protect the collection from the threat of fungi and bacteria while allowing the temperature to vary, since chemical aging and mechanical damages were not considered to be threatening.

Engineering Design of Climate Control System

The conceptual design of the climate system was forwarded to a local architect and HVAC company for detail design, equipment selection, and installation under the authors' supervision. Figure 2 shows locations of various HVAC equipment for the storage. The system consisted of two large [953 cfm (1620 m^3/h) each] centrifugal-type supply fans, four [424 cfm (723 m^3/h) each] axial-type exhaust fans, six oscillating fans, four portable mechanical dehumidifiers [177 cfm (300 m^3/h), 1331 Btu/h (390 W) each] and two humidistats. The supply air ventilators were placed outside the building, bringing filtered outside air through two centrally located ducts mounted under the ceiling, and distributing air through five diffusers on each side. Each supply fan had an insect net and double banks of G3-type particle filters. The venting air, after flowing through the shelves and drawers, was collected near the floor through two ducts with five return openings each, and along two walls which were parallel to the supply air ducts, and ducted to the exhaust fans located in wall cavities. Gravitational-type shutters were installed on their exhausts to prevent the infiltration of the outside air and insects. Four portable dehumidifiers connected to permanent drains were located near four corners of the storage room. Three oscillating fans mounted near the ceiling on sidewalls operated with the dehumidifiers for mixing the room air. Another three oscillating fans, independently operable, were installed on center columns to provide comfort for staff members and researchers. Two humidistats, with one relative humidity sensor inside the storage and the other outside the building, controlled the operation of ventilators, fans, and dehumidifiers. The climate system operated only when the interior relative humidity exceeded 70%, and deactivated once the relative humidity was reduced to equal or less than 60%. The ventilators (supply and exhaust ventilators) were operated simultaneously when the outside relative humidity was equal or less than 70%. If the outside relative humidity rose higher than 70%, wall fans and mechanical dehumidifiers were activated simultaneously, while ventilators were turned off. Costs of the detailed design, the equipment, and labor for the installation were approximately R$4.33/$ft^3$ (R$153/$m^3$) in 2003, less than one-fifth of a typical climate control system which controlled both temperature and relative humidity.

Building Envelope Modifications

For the installation of the climate control system, some architectural modifications were made on the building envelope of the new storage space to improve its air tightness. The modifications included the elimination of a large steel door directly leading to the outside and wall openings for air-conditioners. Some of the wall openings were converted to windows. The ceiling was insulated with 4 in. (0.10 m) thick fiberglass panels to minimize the heat transmission from the attic. An area surrounding the storage was paved for improved drainage around the building. Two fireproof metal doors were installed: one at the entrance to access the storage, and the other to access the conservation lab. A vestibule area was created just outside glass entrance doors into the storage surrounded by the two metal doors and a brick internal wall. This area provided a transition space between the storage and