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ARCHITETURE OPTIMIZATION AT IPEN ANIMAL FACILITY IN ORDER TO IMPROVE THE WELFARE AND THE QUALITY OF THE ANIMALS EMPLOYED AT RADIOPHARMACEUTICAL TESTS

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ABSTRACT

The production and the issue of high quality laboratory animals are essentials for the accomplishment of vanguard scientific research, with reproducibility and universality. The quality of those animals depends, largely, of the available facilities for their production and lodging, to assure the demanded sanitary control and animals' well being, in agreement with the ethical principles that control the activity. The facilities also have to fill out other requirements, such as: the functionality of the environments to make possible the suitable and efficient handling of the animals, facilitating the execution of the routine activities; the respect to ergonomic principles to provide a safe environment and the operators' well being. The facilities design is of vital importance so that the mentioned requirements can be reached. The project of the Nuclear and Energy Research Institute (IPEN) Animal House Facilities was accomplished in the year of 1964. However, by that time there were not the current recommendations with respect to the sanitary, genetic and environmental controls. The facility was planned with the objective of being a production unit and a local for keeping of defined animals from sanitary, genetic and environmental point of view. Nevertheless, the original unit drawing presents an unsuitable distribution of the area where animals are stockpiled and different activities are performed. The Animal House Facilities occupies an area of 840 m^2, with one pavement, where the production areas and the stock of original animal models of the own institution are distributed, as well as the maintenance of animals from other national or foreigner institutions. It supplies rats and mice for biological tests of radiopharmaceutical lots, produced in IPEN, before they be sent to hospitals and clinics spread out in Brazil, for use in Nuclear Medicine. It also supplies rats and mice for tests of odontologic materials, for tests with growth hormones and for researches of new radiopharmaceuticals, among others applications. Many of the animals models produced in IPEN are unique in Brazil and they constitute, therefore, an important patrimony that should be preserved. This paper describes the activities that have been executed in Animal House Facilities of IPEN, including the refurbishment project and the adaptation of the facilities.

1. INTRODUCTION

The production and the issue of high quality laboratory animals are essential for the accomplishment of vanguard scientific research, with reproducibility and universality. The quality of those animals depends, largely, of the available facilities for their production and lodging, to assure the requested sanitary control and animal's welfare in agreement with the ethical principles that control the activity. The facilities also have to fill out other requirements, such as: the functionality of atmospheres, which lead to an appropriated and

efficient handling of the animals, facilitating the execution of the routine activities; the respect to the ergonomic principles, providing a safe atmosphere and welfare to the operators.

The facilities architecture is very important to reach the mentioned requirements. Nevertheless, the project of the Nuclear and Energetic Research Institute (IPEN) Animal House Facilities was accomplished in the year of 1964. By that time, there were not the current recommendations with respect to sanitary, genetic and environmental controls. Besides this, the progress in the knowledge and the increasing of quality requirements for the produced animals, allied to the readiness of new materials and new constructive solutions, implicate in the need of revaluation of the layout of the installation and of corrective maintenances [1].

2. CURRENT STATUS OF THE ANIMAL HOUSE FACILITIES AT IPEN/CNEN - SP

The IPEN's Animal House project was planned to be a unit for animal production and maintenance. The original architectonic drawing shows an unsuitable distribution area, impairing the necessary segregation of after assays animals, from those inside the production and stock colonies, as well those with genetic background drifts.

The Animal House was installed in an area of 840 m^2 that is one pavement, where the production and stock units were designed to support the needs of our own Institution, as well the maintenance of animals originated from other national or international institutions. Many of the models produced at IPEN, are unique in Brazil and constitute an important patrimony that should be preserved [1]. On average, 3500 animals are maintained at IPEN.

Located at Biotechnology Center of IPEN, the facility also supports researchers from the Directorate Radiopharmaceutical Institute, supplying mice and rats for biological tests of radiopharmaceutical shipments. Before reach hospitals and clinics spread out in Brazil, the product produced at IPEN, for use in Nuclear Medicine and also for research of new radiopharmaceuticals, has to be tested in animals. Moreover, the Biotechnology Center uses mice and rats for studies of new radiopharmaceutical candidates among others applications.
During the initial project, some aspects were not considered. Norms and biotechnological safety concepts such as sanitary barriers; access restrictions of people and materials; separation between the breeding and experimentation areas, and internal flows were not observed. Related to the physical infrastructure, the due attention was not given to the choice of the construction materials. Nowadays, most of them are not acceptable from the sanitary point of view, because they implicate in risks to the health of the facility staff, besides it causes damage to the quality of animals, environment and also to the ongoing research. This environment allows the arising of pathogenic colonies, once it is not possible to establish disinfection routines satisfactorily, as recommended by sanitary quality protocols [1].

Nowadays, the IPEN's Animal House Facilities present revetments worn down by use and also with unsuitable project solutions taking into account the norms that should be adopted to the good operation of the facility. In the Rooms of Animal Breeding, the walls are covered with tiles, which impede the correct hygienic practice due to the dust accumulation at the tile junctions. The cages are arranged in shelves done in concrete, built in three levels at the

longitudinal axis of the room, as can be observed in the figure 1. That solution is not acceptable considering the new concepts of animal house facilities, due to the fact of the lining not to be suitable, because it propitiates the accumulation of dirt, also impeding the sanitation of the rooms. With concrete shelves, it is impossible to solve the problem of the air circulation among cages, since, this kind of shelves, do not allow the appropriate change of the air inside the cage. This poor air circulation leads to lung infections for the animals, as a consequence of the high level of ammonia. Additionally, this shelf type limits the space inside the room, avoiding the increase in the number of animals [2]. Besides, with this system its possible the presence of termites, as can be observed in the figure 2, that makes unfeasible the maintenance of an efficient sanitary pattern.

Figure 1: Shelves in concrete and walls lined with tiles.

Figure 2: Masonry with termite.

The windows have common glasses, what means the possibility of violation, as presented in the figure 3. The wood doors are quite deteriorated due to the termites, with cracks, disabling their perfect operation and liberating particles that contaminate the area and impede the correct sanitation, as observed in figure 4. The viewfinders of the doors are not also suitable, because they have reentrance that accumulates dust.

The illumination of the animal rooms is not effective, because the lamps are exposed, without any protection. This propitiates the dust accumulation, impeding the correct cleaning and acting like another polluting factor of the area, as shown in the figure 5 [2].

The floor of the Animal House was constructed with granulites and now it is worn down and with mendings. The junctions between the walls and floor are not rounded. The existent roof was made of plaster (gypsum) plates and it presents cracks and stains, due to water leaking, permitting the entrance of insects and other dirtiness, what turns more difficult the contamination control.

Figure 3: Windows with common glasses, without isolation from the outdoor environment.

Figure 4: Deteriorated doors.

The main access to the facility is by a single door, linked directly to the exterior of the unit, exposing animals, people and activities to the outside environmental conditions and contaminations, allowing the entrance of insects and dust, impairing the sanitary colonies protocols, as shown in figure 6.

Figure 5: Exposed lamps without any protection.

Figure 6: Main entrance of the Animal House Facility.

Additional problems were identified in the facility, such as the first room immediately after the main entrance that is used by the employees and the contiguous room is a pantry, observed in the figure 7, installed in a completely unsuitable place, according to the Biological Safety Norms.

In the storeroom, openings are observed in the walls and in the floor. Moreover, the installation of windows permits direct contact with the external area, without screen protection against insects. Soon afterwards, we have the pine shaving Stockpiling Room and the adjacent room is for Animal's Food Stockpiling. Both rooms have windows, what is not advisable [3]. Other serious problem, observed in those rooms, are the termites that attacked the door's wood, besides they make ways in the masonries.

The Material's Washing Room is the area where the sanitation activities and sterilization of the materials used in the maintenance of the colonies of animals are concentrated. In the entrance of the room, there is a channel with iron grill and the width corresponds to the space of the door, what caused several incompatible situations, as blockage, ebb of water, entrance of insects, besides representing a point of constant contamination in the room, as observed in the figure 8.

Figure 7: Pantry located inside the Animal House Facility.

Figure 8: Channel with grill in the floor.

The existent tanks in the Material's Washing Room, observed in the figure 9, were built in concrete. Now, they present countless cracks that impede the perfect disinfection, committing the quality of the materials sanitation done at the room.

Figure 9: Existent tanks in the Materials Washing Room.

Another relevant point that should be mentioned is the lack of an air exhausting system that would allow the removal of great part of the heat generated by the autoclaves. The heat compels the technicians to maintain the windows opened, acting as a conflict to the recommended isolation of the room [2]. In the whole extension of the circulations, closing was built with concrete bricks with openings, allowing the direct contact with the outside part, allowing the entrance of insects, wind, dust, what hinders the cleaning procedure as well the environment sanitation.

Although it is recommended, there are no seals or gaskets in the windows of the Experimentation Rooms [3]. Due to the inexistence of a system of air exchange, it is necessary special attention, because there are several pollutants that have be removed, being the ammonia the most important of them, since they could interfere in the experiments and also to commit the quality of the technicians' living area [2].

Now, the main entrance of the Animal House Facility of IPEN, used by personnel as well as materials and services, it is done through a single door, without barriers, linked directly to the building internal area. Besides this, there no control of the people's flow, what is fundamental for a good operation of the unit. That situation commits the correct operation of the Animal House Facility, with respect to the biological safety concepts, as environmental decontamination, disinfection, elimination of dejections in conditions of safety, because they expose the employees, the animals, the technicians and the research activities to risk situations [4].

3. ADAPTATION PROJECT AND REFURBISHMENT OF THE ANIMAL HOUSE FACILITIES OF THE IPEN-CNEN/SP

This work consisted of three main activities: 1) evaluation of the state of the unit from the architectural point of view; 2) a revision of their several constructive aspects, in agreement with the principles and recommendations presented in the literature; 3) preparation of a plan to optimize the Animal House Facility.

The accomplishment of this study was based on the critical and detailed analysis of the facility, with objective of generating a proposal for its adaptation and the adoption of new procedures. For so much, the existent situation was confronted with the information presented in the literature. Other similar laboratories were also visited, in order to exchange know-how with people in charge and operators of those facilities. Finally, it was accomplished a search of alternative materials and equipments with the respective suppliers.

3.1 First Stage of the Facility Refurbishment

For the first stage of the refurbishment, several modifications were proposed. However, due to the budget restrictions and the scarce available resources, the extension of the reform was limited, contemplating just some items considered priority. In this reform, the masonry of some rooms was demolished, allowing the union of adjacent rooms, with the objective of enlarging them to assist to the Breeding Section with controlled sanitary quality.

Several changes were introduced in the Animal Rooms area, such as the replacement of the existent deteriorated doors by others with viewfinders and appropriate covering, to facilitate the maintenance and cleaning; the installation of viewfinders in the masonries for visual communication among the adjacent areas; the replacement of the window with ventilation for fixed windows; closing of the existent space in the masonry of the circulation area; restoration and polishing in the granulite floor, with application of impermeable resin; substitution of the plaster lining for PVC lining; masonries of the Animals Rooms painted with epoxy resin; PVC piping installation in the superior part of the masonries for future installation of the exhausting piping; replacement of the existent open lamps for closed lamps; demolition of a tank and substitution of the lining of the existent tanks; creation of a Room of Support in the aseptic area; construction of walkway in the masculine and feminine dressing-room to wear sterile clothes and opening of spaces in the masonries for installation of pass-through. A second corridor was created for the Breeding Rooms sharing them in aseptic figure 10 and septic figure 11 areas, creating an unidirectional flow essential as a sanitary barriers for the good operation of the Animal House Facility.

The corners formed by the walls with the floor and roof and between two walls, were rounded to facilitate the cleaning and the disinfection. All of the masonries were covered and painted later with epoxy resin, in order to offer great resistance for the disinfection routines.

Figure 10: Aseptic corridor.

Figure 11: Septic corridor.

In the aseptic and septic circulation, galvanized tubes with electrostatic painting were installed to protect the inferior part of the masonries figure 12, avoiding damages caused by trails and others equipments. In the inferior part of the double door, a protection was installed to avoid the entrance of insects and dust figure 13.

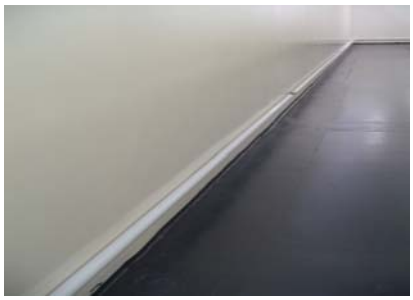

Figure 12: Galvanized tubes to protect the masonries.

Figure 13: Protection in the door to avoid the entrance of insects and dust.

The wood doors were replaced by coated doors (Formica) built with double glass viewfinders, faced with the door surface figure 14. There was a great concern related to the used materials and the way they were applied, to avoid openings or saliencies. It was opened a space in the masonry and a door type counter were installed, linking the Septic Circulation to the Washing Area.

Figure 14: Doors with viewfinders.

3.2 Second Stage of the Facility Refurbishment

The objective of the second stage of the Animal House Facilities refurbishment, is to adapt the Animals Reception and Materials Storage rooms, eliminating the direct contact of the building's interior with the external part; to segregate the Breeding and Experimentation areas; to establish flows to avoid contaminations and to create an appropriate and effective sanitary barriers for a good operation of the unit, assuring quality and health to the animals and staff. The entrance to the Breeding Area of the Animal House will be made by a single access. All the other existent entrances will be closed, to allow the isolation of the facility from the remaining building. It will be installed a controlled access glass door, to entry in the facility. The access is only for authorized people, by means of a password. The access will be authorized to the smallest possible number of people, in order to allow the control of the environment and assisting mainly the basic concepts of the biotechnology safety norms. The entrance for the Air Conditioning Equipment Room was isolated from the internal areas, facilitating the repair procedures. The garden will be isolated by a low wall that will be built and covered with fixed glasses. The garden can be seen, however without risks of contamination. The Pantry, that is located in the circulation entrance adjacent area, it will be totally isolated from the facility. At the room reserved for the issue routines, a service window will be installed for the contact with the external public and technicians, avoiding their access to the internal facility areas. The granulite floor will receive a layer of acrylic resin. In the area of the new circulation, the floor will be built in granulite covered by resin and round corners will be adopted in the same pattern already described. The new circulation will permit the access of materials in a controlled way. The Experimentation Area will have an independent access with the objective of its isolation, facilitating the passage of materials and equipments without interferences in the flow of animals, people and materials.

With the refurbishment, several procedures are being modified, with the intention of improving the flows and to avoid crossed contaminations, mainly with the pass-through installation. The pass-through was installed, for material passage from the Aseptic Circulation area for the Surgery Room. This equipment limits the people's movement inside the Clean Area and it also separates the dirty operations. Any material that goes by the pass through is previously disinfected. In the exit of the Animal's Breeding Room, another pass-through was installed between the Septic Circulation and the Laboratory, to assist the Animals' Experimentation Area. The material or animal is given without the contact among people, limiting to the maximum the contamination in the Animal's Breeding area. Another pass-through was installed between the Animal Supply Room and the Main Circulation of entrance of the building, for external service. The access to this room will be only allowed to the authorized people that leave the Animals Rooms or for the access door installed at the Washing Room, without interferences with the Animal's Breeding Rooms. In the Animal Supply Room, a ventilated shelf will be installed, where the solitary animals from the Breeding Rooms will be kept until the moment of the delivery to the researcher. The animals will leave the Animals Room in microisolators, in order to avoid contaminations during the trip to the laboratory. Partitions will be installed in the facility internal circulations. They will have locks with opening from only one side of the door and they will isolate the Animals Breeding area from the Experimentation area that, nowadays, is used for rabbits and in the future will be a experimentation area with mini-pigs.

3. CONCLUSIONS

The reforms and adaptations in the Animal House Facilities of IPEN will stimulate the introduction of new procedures, with effects for the animals and technicians. It will be instituted in the operation of the unit, routines that are able to assist better the biological safety norms and to assure the animals' well-being and the employees' health. Obligatory sanitary barriers are being created to limit the people's access, favoring the maintenance and also the animals' welfare, adapting the building areas for improving the flows inside the facility. It is being instituted the segregation of the Animals' Breeding Area from the Experimentation, creating independent circulation for entrance of materials and services, introducing unidirectional circulations in the Animals Breeding area to eliminate cross flow and the direct contact with the external areas. These actions seek items that are fundamental for the good operation of the Animal House Facility and how to eliminate interferences and contaminations, offering a more appropriate atmosphere, avoiding risks, etc. With the closing of the spaces of the masonries with glass blocks, the facility will be totally isolated of the remaining building already existent, impeding the no identified people circulation inside the unit.

The refurbishment of the Animal House Facilities of IPEN doesn't become exhausted with those improvements. Actually, some materials are not yet satisfactorily adapted. For instance, in the case of the existent tanks in the Washing Room, there was a significant improvement, but the ideal material for their covering would be the stainless steel. However, due its high cost and to make possible the largest number of items to be executed in this stage of the refurbishment, the ceramic covering was adopted. It assists to the needs concerning the resistance, but it is not satisfactory due the existence of tile junctions. Another example is the floor in granulite. This is resistant, nevertheless it presents porosity. The application of an acrylic resin is essential to minimize the problems. The monolithic floor would be much better, because the total absence of junctions. Besides this, it is resistant to chemical products and its cleaning and disinfection is easier.

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