Having been removed from their original context, which favored their preservation, the naturally mummified bodies of the National Museum are at present exposed to all sorts of factors that can cause irreversible deterioration. Changes in temperature, biodeterioration, photo-oxidation, and pollution, among others, create harmful conditions from which such organic materials must be protected. Even substances, such as phenol, that are being used to preserve these mummies from insects, fungus, or bacterial attacks are likely to cause reactions on the skin's surface and thus have long term caustic effects. Such dangers are also compounded by the museum's heavily trafficked urban area (emitting high amounts of oxidants), lack of air filters (to remove soot and dust), drastic changes in temperatures, etc.

In order to counter such unfavorable conditions and thus preserve the mummies for generations to come, a solution had to be found that would not only abate threats to the mummies but would also prove possible within the limited facilities of the National Museum. To that effect, the Getty Conservation Institute has developed an "inert atmosphere case" that is being used for the long term preservation of the Egyptian Museum's collection of pharaonic mummies. The GCI case is a hermetically sealed volume that, when flushed with an inert gas such as nitrogen, creates an environment wherein deterioration caused and aided by oxygen can be stopped. In such an oxygen-free environment, biodeterioration, insect, fungal, and aerobic bacterial attacks can thus be controlled and so can anaerobic bacteria when relative humidity inside the case is reduced to less than 50%. Phenol and other such disinfectants would no longer be needed once mummies are placed in an inert environment. The advantages of such a case also include the fact that original requirements, set by the GCI, suit both the needs and present state of the National Museum: "the system should not rely on a mechanical or electrical sub-system for maintaining its performance; should require minimum maintenance...; should be easily manufactured, even in developing countries; and the cost per unit should be contained within a reasonable range."[1] These requirements are ideal for a museum in Lebanon and mean that the case would operate as a static system that requires no external source of power, could be left unattended for long periods of time (for about a decade), and should be easily manufactured in a standard machine shop. The fabrication of the inert atmosphere case, however, remains somewhat costly in terms of the limited funds available to the National Museum. Some of the case's components consist of intricate aluminum extrusions that can not be easily manufactured in Lebanon. It soon became clear, therefore, that while the case is most certainly appropriate for the museum's mummies, an alternative solution based on the same principles was needed. Mr. Shin Maekawa, Head of Environmental Sciences at the Getty (and author of the GCI case) kindly provided the information needed for us to find, at first, an inexpensive temporary measure for the mummies' immediate protection and to later design and produce a lightweight variation on the original case that could either be produced locally or be easily shipped from overseas.

The first measure consists of bagging the mummies in a soft envelop that can be heat sealed and flushed with nitrogen. Bags were hence prefabricated in Houston for the mummies to be placed in and to thus immediately reduce the rate of decay by creating an environment that has less than 0.1% oxygen and whose relative humidity can be maintained at 45%. The bags are fabricated from an oxygen barrier film called "Filmpack 1193" that, unlike ordinary plastic films, allows minute transmission of oxygen (rate of oxygen transmission: 0.1cc/m^2/24hrs, water vapor transmission: 0.47gm/m^2/24hrs, thickness: 0.125mm). The bags are also fitted at both ends with high grade Swagelok™ O-ring sealed valves that are directly attached on the film. A ball valve at one end and a purge valve on the other, thus facilitate the periodic flushing of the bag with the inert gas. The second measure consists of a lightweight rigid version of the GCI case made of a large acrylic cylinder sealed with aluminum plates at both end. In terms of performance, it should meet all of the requirements set by the Getty and will be less labor intensive to construct. Mummies will be placed on an anodized/perforated aluminum stretcher that will also house sensors and passive control agents needed to act as humidity buffer (silica gel), oxygen scavenger (Ageless™, used in vacuum-packaged foods) and pollution sorbent (activated carbon). A pillow shaped bellows will also be placed inside the stretcher to alleviate the case's joints from pressure caused by temperature and barometric fluctuations. Input and output of the inert gas, will be performed via ports on the aluminum end plates, which will also be equipped with a pressure relief valve for added safety against pressure build-up during oxygen purging.

Considering the limited capital at our disposal, this variation on the original case is an appropriate medium to longterm solution. It should cost less than what it would take to build the GCI case, will be light in terms of transport, and its joints to be sealed will be kept at a minimum in length thus reducing chance for leakage. At this point, the case for the National Museum's mummies remains in a design stage and will be produced in the near future pending availability of funds.

Notes

[1] S. Maekawa and F. Lambert, *The Getty Conservation Institute's Inert Atmosphere Display and Storage Case for the Pharaonic Mummies of the Egyptian Museum*, Cairo, The Getty Conservation Institute, December 1993, p. 6.