D. External Financial Programs: Linkages

Given the argument that a successful resort enterprise in Iceland would require extraordinary resource expenditures to achieve sufficient international impact, tourist appeal, and conceptual feasibility, it has nonetheless been shown that such a scale jeopardizes financial feasibility. To reconcile this dilemma, several financial linkages -- external to the resort project -- were examined in anticipation of generating additional, outside revenues which could be applied to the capital and operating requirements of the resort.

The first of these plans involved the use of the resort and micro-climate as a unique and highly supportive element in a specially-themed international exposition. Thus, the exposition and resort could be treated as "joint products" of the micro-climate and infrastructure, lessening the cost burden of the resort itself, as well as serving as a visible focus for international attention.

The second external linkage plan examined the possibility of exacting a surcharge on airline passengers traveling to and from Iceland. The passengers would subsequently be entitled to a tour of the resort and micro-climate at no extra cost; however, the surcharge would not be refundable for those not availing themselves of the opportunity.

1. Exposition

Aside from the importance of potential exposition revenues to the financial feasibility of the resort, an international exposition -- with its attendant publicity -- would have considerable long-term impact upon all segments of the local economy (especially the service-oriented segments). Besides creating a larger and higher quality service infrastructure for the enjoyment of residents and future tourists, an international focus upon Iceland and its industries would spread subsequent benefits throughout the economy.

The Bureau of International Expositions (B.I.E.) recognizes and approves two major categories of international shows: (1) Universal Exposition (e.g., Montreal Expo '67, Japan Expo '70, etc.), which are the extensive, more elaborate, world fairs, with national participants given great leeway in designing and theming their pavilions and (2)

Special Category Expositions (e.g., Spokane Expo '74, Okinawa Expo '75) which are generally smaller, more narrowly themed affairs. For example, the Spokane Fair highlighted environment while the Okinawa theme is oceanography and the sea. In the case of Iceland, a special category fair with an energy theme would appear most appropriate. A third category exposition is the short duration Trade Fair where products or technology are displayed and marketed by interested nations. Although not requiring B.I.E. approval, it would involve the local sponsorship of an industry or special interest group that could attract participation of private profit-motivated firms around the world. The lack of a strong theme, the difficulty of access, and the small local market would, according to exposition experts, lessen the chances of marketing a successful Trade Fair in Iceland.

Although Iceland is no longer a member of the B.I.E., this would not pose any insurmountable problem for obtaining their approval of a special category exposition in Iceland. It would, however, require a planning process and proposal that could run one or two years and cost several hundreds of thousands of dollars. First and foremost, it would require a total commitment by the government to sponsor, organize, and oversee the operation. Potential advantages and disadvantages of a special category (energy) expo in Iceland are discussed below.

a. Incremental Costs and Revenues

Preliminary costs for the additional site work, including both infrastructure and superstructure, were estimated at between \$10-15 million. Resort and exposition total costs were, therefore, estimated to range between \$70-75 million. A discounted cash flow analysis was performed to ascertain the level of exposition revenues that would be necessary, along with the previously determined hotel/resort returns, to insure an adequate return (10-15 percent) on the total \$70-75 million investment. The resultant calculations indicated that approximately \$50-60 million net exposition revenues would be required, on at least \$150-200 million gross visitor spending. Translated into actual visit-occasions, this would mean approximately 10-15 million visitations over a four to six month Fair duration. Obviously, such levels present extremely difficult conditions which mitigate against the exposition approach. These are discussed below.

b. Shortcomings and Difficulties in the Exposition Approach

The level of required visitor participation poses obvious problems for Iceland since expositions rely rather heavily on local visitations and the small local population does not provide a sufficiently large base for this support. Therefore, outside visitation at extremely high levels would be required. This would present the following problems:

- Accommodations would have to be built (at additional expense) which would not thereafter be necessary to handle the steady state level of Icelandic tourism. Since much of the Fair visitation would be by charter groups and since these generally cannot be scattered among several hotels, it would necessitate uneconomic changes in the scale of the individual hotels, as well as the industry at large.

- Creating the accommodations and support facilities for such mass tourism would be inimical to Icelandic objectives of providing tourism facilities for lower levels of more special interest visitors.

- External effects of such high concentration of tourists would put a strain on the guest-host relationship that Iceland would prefer to create; in addition, a Fair at the Kleifarvatn site would greatly alter the environmental quality of the area.

- Transport of this number of tourists to Iceland would involve several quantum jumps in the level of air service to Iceland, straining both physical and human resources.

The planning and organizational requirements also present problems, one of which was alluded to before. The total national commitment of resolve and resources would mean not only an assumption by the Government of responsibility to serve as sponsor, organizer, and liable agent for the Exposition (especially in the absence of membership in the B.I.E.) but also would entail moral commitments to other nations to participate in their Fairs in the future.

The Exposition possibility, therefore, seems to raise new problems and questions with additional commitment of resources rendering the joint resort/exposition concept infeasible. Finally, it should be added that small international festivals -- unrelated to the resort or micro-climate but similar to the biennial Reykjavik Festival of the Arts -- should not be ruled out. These should, in fact, be encouraged as a vehicle to direct particular attention and visitations to Iceland at various times of the year. The success of events such as the annual Calgary Stampede in Canada would seem to provide some encouragement for promoting such present and prospective Icelandic events as Sheep Roundup, First Days of Summer, and Viking/Saga Festival. Like the state and county agricultural fairs throughout the world, these fairs should be directed at the entertainment of the local population; but, with the promotion of the Icelandic Tourist Bureau, these could provide additional motivation for visits to Iceland.

2. Airline Ticket Surcharge

The possibility of levying a surcharge on airline tickets as a source of incremental revenue for the resort was also examined on a discounted cash flow basis. Advantages and disadvantages are discussed below.

a. Incremental Revenues

As in the exposition case, the level of the necessary surcharge to partially offset the cost of the resort complex (by offering/providing day tours of the resort to Icelandic travelers-passengers) was calculated. Since these tours would involve some cost to provide the transportation and other services for the visitors, net surcharge revenue was the relevant parameter considered. Depending upon the type of passenger that would be levied with a surcharge, the net surcharge revenue would have to be at the wholly excessive rate of $22 per capita (if the charge were exacted upon 200,000 annual passengers -- or roughly one-half of total departures in 1974). Over 25 years, this would result in a 10 percent internal rate of return to the resort and micro-climate (combined with the revenues of the resort itself). A net surcharge revenue of approximately $9 would result in only a 5 percent overall return. Thus it appears, in isolation, that any economically justifiable surcharge would have insufficient effect on overall profitability, particularly when it is remembered that the gross surcharge (or actual assessment per passenger) would have to be higher to cover the costs of offering the tours. The additional problems of such a procedure, moreover, are myriad. These are discussed in the ensuing paragraph.

b. Shortcomings and Difficulties in the Surcharge Approach

Besides the purely economic problem outlined above, there are other salient reasons for rejecting the notion of a surcharge. First of all, there is some question as to whether such a surcharge system is legal under The Civil Aeronautics Board mandate outlined in Aeronautical Statutes and Related Material. Since Icelandic Airlines utilizes U. S. airports, it would be enjoined under Section 403(b) of that Act from offering a "rebate" of part of the ticket price to its passengers; i. e., the offer of a free tour of the resort could be interpreted as an indirect refund in the nature of a "free" service. Moreover, since the CAB requires justification of any fare increase, it could simply reject the price increase as not substantiated by the airline's operating costs or requirements. The relevant portion of the section is reproduced below:

> "Section 403(b). Observance of Tariffs; Rebating Prohibited
>
> No air carrier or foreign air carrier shall charge or demand or collect or receive a greater or less or different compensation for air transportation, or for any service in connection therewith, than the rates, fares, and charges specified in its currently effective tariffs; and no air carrier or foreign air carrier shall, in any manner or by any device, directly or indirectly, or through any agent or broker, or otherwise, refund or remit any portion of the rates, fares, or charges so specified, or extend to any person any privileges or facilities, with respect to matters required by the Board to be specified in such tariffs, except those specified therein."

A major consideration would also be the logistical problem of scheduling half-day layovers to accommodate those passengers disembarking for the tours. Since the current Icelandic aircraft inventory does not provide sufficient numbers of scheduled flights to allow immediate continuation of the original Europe-bound flight and a later afternoon flight for the passengers taking the tour, several costly alternatives must be considered. Either the airline must reschedule its continuation to Europe for the afternoon, thereby grossly inconveniencing its non-touring passengers or it must procure other aircraft for afternoon flights. Conversely -- if the touring passengers were forced to continue their trip to Europe on the following day -- this would mean the imposed cost of a night stopover (thereby eliminating the notion of a prepaid "free" tour).

Finally, and probably most importantly, a risk of seriously alienating the Icelandic passengers would be run and the subsequent loss of good will would impose additional competitive burdens on the airline. In the face of increasing prospects for cheaper air fares (charters, air bus concepts, and the recently adopted Advanced Purchase Excursion

Plan - APEX), this would further erode the current competitive edge of Icelandic, especially in light of the recent imposition by Iceland of an $18 airline departure tax upon local and certain tourist passengers. Although the airline's greatest long-run potential would seem to lie in the direction of increasing destination (as opposed to transit) traffic to Iceland, this would best be done by more conventional methods of promotion rather than through mandatory tour purchase plans like the surcharge.

Summarizing the results of both potential sources of outside revenue, viz., exposition and surcharges, it becomes clear that neither can be viewed as potential panaceas. The large initial capital requirements for the resort cum micro-climate cannot be obtained through either device nor can such a capital expenditure (even if it were heroically assumed that these investments were forthcoming from other sources) be successfully amortized by their contributions of incremental income. Each might make some modest contribution to that end; however, real, meaningful solutions must be sought in terms of tourism programs scaled and attuned to more realistic and limited Icelandic tourism objectives.

APPENDIX A: SITE DATA

A. Climate

Currently, weather information is being gathered at the Krisuvik site and direct correlations with long-term recordings from surrounding stations will be made following a full year weather cycle. At this time, extrapolations of weather recordings from the surrounding stations at Reykjavik, Keflavik, and Grindavik indicate the following probable climatic conditions.

1. Temperature

Due to the northeasterly flow of the Gulf Current and the southwesterly location and exposure of the Krisuvik site, the temperatures are far more moderate than one would normally anticipate at a latitude of 64 degrees. January is the coldest month with the mean temperature near freezing. During the spring and fall, the mean temperatures range between 5 degrees Centigrade and 7 degrees Centigrade, respectively; while the mean temperature in the summer is 12 degrees Centigrade with several days in July exceeding 20 degrees Centigrade. Although it is never really hot, numerous outdoor activities could be anticipated for nine months of the year; and it is particularly noteworthy that temperatures below freezing will be quite rare at Krisuvik.

2. Precipitation

Located at the boundary of the Circumpolar Vortex where warm moisture laden air from the South meets colder Arctic winds from the North (in combination with the usual condensation from abrupt topographical variations in elevation), Iceland's overall level of precipitation is relatively high. At Krisuvik, however, the lower elevation and southwesterly location indicate that the annual precipitation will range from 1, 600 mm to 1, 800 mm per year. The distribution of this precipitation is reasonably uniform through all seasons, although perhaps 15 percent to 20 percent greater during the winter when the interface of cold and warm airs moves further south. Some of this precipitation, in the form of snow, will cover the land for less than two months out of the year except on north-facing slopes where melting is considerably slower due to the low sun angle and shorter daylight hours.

3. Wind

The prevailing winds are from the south/southeast with an average velocity range of 5m/sec. to 7m/sec. from summer to winter, respectively. Because it is surrounded on three sides by mountains, the Krisuvik site is quite well protected from all strong winds. The recent monitoring of wind direction and velocity at Krisuvik will assist in establishing the appropriate wind and load design which is currently being estimated at less than 6.5m/sec.

4. Sunlight

The angle of the sun at the summer solstice is ±49 degrees while in the winter it drops to ±2 degrees -30', with the range of extreme daylight hours from sunrise to sunset being 21 hours and 4 hours, respectively. While the continuing formation of clouds limits the average number of totally clear days per year to less than 25, this cloud coverage moves continuously and over 30 percent of the daylight hours are blessed with full, bright sunshine.

B. Seismology and Volcanology

Because it is very young in terms of geologic time, Iceland's internal structure is quite dynamic and presently in a period of comparatively high activity. Although there is no precise means by which to determine exactly where and when a volcano could occur or the location, severity, and duration of a major earthquake, there are numerous indicators which favor the selected Krisuvik site for the proposed development. The prime indicator of a low risk situation is that the underlying rock structure is not comparatively solid, thereby precluding the buildup of major tension stresses. The energy from any tension is released internally at regular intervals in a form of tectonic settling called "swarms". This displacement, which occurs two or four times a year, is completely underground with only minor vibrations felt at the surface. The preferred structural design standard for this type of seismic activity is a lightweight and flexible structure with major supporting elements built to withstand an intensity of eight (8) on the Mercalle Scale.

C. Soils and Geology

During this study, a surficial and subsurface soils exploration program was underway at Krisuvik to determine the specific characteristics of the soils and their adaptability to the proposed resort complex. The report and results of these explorations are nearly completed and an analysis and interpretation of these findings will follow shortly thereafter. (It is noteworthy, however, to point out that the general mapping prepared by the Geodetic Institute of Iceland as well as the geologic mapping of the Kleifarvatn region completed in October of 1971, have been most beneficial in determining the overall suitability of Stora Lambafell to accommodate the anticipated construction.) In addition to the loading, tension, and other structural engineering qualities, these explorations will examine percolation and absorption characteristics at several locations to assist in determining the most appropriate method of handling sewer waste as well as the topsoil management and erosion protection necessary during the construction and recovery periods, and the soil additive requirements to support a variety of vegetation and reforestation alternatives.

D. Access

The only means of access to the site is by automobile, bus, or similar vehicles. However, the eventual inclusion of sea and ski aircraft service on Kleifarvatn would open up the glacier exploration and salmon fishing potentials from other than remote base camp locations. Helicopter service could also provide special access to the "mini museums" or other points of interest for the short term visitor.

Given the project daily traffic volumes, the road between Hafnarfjordur and the north end of Kleifarvatn will require widening and hard surfacing. Due to the fragile soils and narrow corridor along the northwest edge of Kleifarvatn, studies should be undertaken to investigate a bypass road near the present track on top of the northwest ridge, terminating near Borgarholl and connecting with the Coastal Highway.

E. Regional Planning

Two developments presently being considered in the Kleifarvatn region which will have a significant influence on the resort facility and the direction, type, and rate of growth in the region are the ski area at Blafjoll and the People's National Park (which would include the ski area and the proposed resort) between Halfnarfjordur and the south coast. Both of these developments would be extremely compatible with the tourism facility and numerous planning functions and cost sharing benefits could be realized.

Although the main vehicular access to Blafjoll would be from the paved road between Reykjavik and Hveragerdi, the area between the Alpine Skiing Center and Krisuvik would serve beginner and especially cross-country skiing very well. The linking of life services for mutual benefit should be investigated early in the design process if the possibility of this facility is moving forward.

Within a national park concept, the resort could serve as the park focal point and headquarters; while the overall development of Kleifarvatn's water activities, access, and control points, overviews, and points of interest, scenic easements, and permissible land uses would have meaningful and outstanding interrelationships.

APPENDIX B: TECHNICAL DESCRIPTION

A. Structural Aspects

1. Roof Structure

The Great Roof encloses approximately 60,000 square meters of climatically controlled space. The roof is comprised of a doubly curved surface having negative Gaussian curvature. The roof structure is generated through the use of three separate sets of cables oriented at 120 degrees to each other.

The structural integrity of the roof is achieved through a combination of the initial prestress induced in the cable systems and the curvature of the roof. In general, a sag-to-span ratio of approximately 1:10 is achieved for all cables. This sag-to-span ratio is required in order to maintain the required rigidity against environmental forces, of which wind is the most severe.

The roof structure is designed to resist 150 mph winds. Under this condition, the overall effect on the roof is that of uplift. Wind tunnel test will eventually be required in order to ascertain the exact wind loading.

2. Roof Covering

Recent developments in the field of structural fabrics have led to a wide-spread increase in the use of tensile structures. Teflon-coated fiberglass is capable of lasting 25 years and of providing a fire-resistance rating. Each year new combinations of fabrics and reinforcing are developed. Each type of fabric offers certain advantages and disadvantages from a cost and life viewpoint. The final selection of the exact configuration of fabric will be made in a subsequent phase of design development.

The roof fabric will be provided in a double layer configuration in order to allow an air pocket to provide insulation to reduce heat loss. Air pressure will be induced into the pockets in order to maintain a tight fabric and thus eliminate flapping. During severe snow falls, the air pressure within the pockets will be reduced so that the outer layer of fabric will sag down and contact the inner layer, thus allowing the internal heat to melt the snow.

3. Towers for Great Roof

The intermediate towers or poles which support the roof consist of large diameter steel tubular members. These towers are designed to allow their use as the main erection supports. It is anticipated that the entire cable roof will be laid out on the existing grade and erection will be accomplished by jacking the roof up the towers as erection poles.

4. Edge Supports of Great Roof

The perimeter of the Great Roof consists of a continuous concrete abutment. The abutment consists of a series of concrete ribs or abutments spaced approximately 10 meters on center. The cables forming the roof are anchored into a continuous concrete beam which is supported on the ribs. A continuous footing supports the entire abutment. The spaces between the ribs will be cellular, with provision made to fill these areas with soil or rock from the site in order to provide resistance to the horizontal forces induced by the cables.

B. Infrastructure

For all practical purposes there is no infrastructure available at Stora Lambafell for a project of the size contemplated in this report. Therefore, all basic services will have to be brought to the site from infrastructure facilities located elsewhere in the country or will have to be developed locally.

1. Electrical Service

A high tension line runs between Reykjavik and Keflavik along the eastern coast. We propose to tap into this line and run a high tension branch line directly to the site. At some convenient point near the project the high tension line will be brought underground to enter a switching station located in the basement of the hotel. Power requirements will be in the order of 8,000 KVA.

The primary distribution system will be of a double circuit radial loop configuration with primary-secondary substations placed strategically throughout the site. One substation will service the Hotel and six substations will ring the perimeter of the Enclosure to service the various functional elements within and adjacent to it.

The secondary operating voltage shall be 200 volt, single and three phase (two and three wire) 50 Hertz alternating current.

2. Communications

Telephone, telegraph, radio and television services will be provided to the site in accordance with governing rules and regulations. Where possible, communication lines and cables will be installed along the high tension branch line construction.

3. Potable Water

Potable water sources will have to be developed locally. Two possibilities exist. The first is to develop spring water sources along the hillside to the east of the project. The second is to use the water from Lake Kleifarvatn. In both cases, the sources should have a capacity of about 30 liters per second (600 gallons per minute) peak demand or of about 473,000 liters per day (123,000 gallons per day) average daily demand. Water will be treated by chlorination and filtration as required. It is also possible that spring water may have to be cooled, in which case, aeration would most likely be the method used.

4. Fire Protection

Water from Lake Kleifarvatn will be used as the primary fire protection water source. The minimum recommended quantity of flow in the mains will be about 95 liters per second (1500 gallons per minute). The most economical system appears to be one which has a pump station located at the lake front which will pump fire protection water to a storage tank of about 680,000 liters (180,000 gallons) capacity. The tank will be an on-ground storage tank located north-east of the Hotel at about elevation 150 meters and will be approximately 10.7 meters (35 feet) in diameter and 7.7 meters (24 feet) high.

A fire pump installation at the storage tank will pump water into the fire main distribution system at the rate of 95 liters per second. The fire protection system will consist of mains, branches, and hydrants located throughout the site. The Hotel will have standpipes and sprinklers. Additional pumping stations will be installed as required.

The fire water protection system will be activated by a fire alarm system that will tie into the local fire fighting organization office and interconnect to all fire pumps.

Fire pump stations will be serviced by both electrical and diesel-operated emergency pumps.

5. Sewage

Sewage collection and distribution systems will have to be developed locally. The sewage collection system will be straightforward, consisting of mains and branches looping the site along some convenient grid pattern. The mains will be designed to handle flows of not less than 50 liters per second (800 gallons per minute).

There are four possible methods of handling sewage disposal.

The first method would be to inject the raw sewage into the underground substrata in such a manner that the ultimate flow would be towards the Atlantic Ocean.

The second method would be to treat the raw sewage in a primary treatment plant. The effluent would either be injected into the substrata as in the first method or would be discharged by pumping and gravity into the Atlantic Ocean some 13 kilometers (8 miles) away. Solid waste products would be used for land fill and fertilizer within the site.

The third method would be to treat the raw sewage in a tertiary treatment plant. The effluent would then be used locally for irregation or fire water or similar purposes. Solid wastes would be used as in the second method.

A fourth method would be to treat the sewage in a novel manner along lines developed commercially for offshore facilities. The concept consists of pumping raw sewage products into vats constructed somewhat like a pressure cooker. Heat is applied to the outer vat side and the sewage is brought to a boiling point. Liquids are driven off in the form of steam or vapors and gases, either entrapped in the raw sewage or generated by the heat. The resultant product is a sterile, highly nutrient soil which can be used as fill or as fertilizer. The vapors, gases, and steam can be recycled through heat exchangers to effect economies.

While this system has been used in limited offshore facilities, the availability of geo-thermal energy indicates that we should investigate this possibility more thoroughly.

6. Storm Water

The average rainfall appears to be in the order of 150 mm (six inches) maximum per month. This relatively small amount can be adequately handled in a conventional manner. We would investigate the possibility of collecting as much of the rainfall as possible from the roof for use in irrigation or fire protection. In general, the perimeter of the roof and selected low points would have means of collecting rain-water. Open areas, such as parking lots and the like would be handled to drain naturally around the site.

The perimeter storm water collection system would discharge into holding tanks, if deemed feasible, or would be discharged into open drainage fields. If required, combination sanitary and storm sewers would be used.

7. Geo-Thermal Energy

Recent studies indicate the geo-thermal aquafer could yield 80 to 100 liters per second (1, 270 to 1, 580 gallons per minute) of hot water ranging from 200 degrees Centigrade (392 degrees Fahrenheit) to 250 degrees Centigrade (482 degrees Fahrenheit) in wells between 600 and 1, 000 meters deep (1, 970 to 3, 280 feet). On the assumption that the minimum conditions are available, that is, 80 liters per second at 200 degrees Centigrade, there will be an adequate supply of hot water to service all loads in the project.

Estimated load distribution would be as follows:

10 liters per second (160 gallons per minute) for generating domestic hot water.

25 liters per second (400 gallons per minute) for heating during the winter.

28 liters per second (440 gallons per minute) for sewage treatment.

The difference between the estimated capacity of the aquafer and the preliminary load estimate is about 17 liters per second or 20 percent of the total capacity. This difference is a reasonable allowance and indicates that only one aquafer need be developed at this stage in the concept.

The well would be driven along the south shore of the lake where a geo-thermal station would be constructed. The natural hot water would be processed through heat exchangers to yield medium pressure hot water that would be pumped to the site. The hot water system would be laid out in a loop fashion similar to a campus district service system. Secondary systems would serve facilities or terminal units as required.

8. Electrical

Complete electrical distribution system for power, including feeders, transformers, protective devices, panels, branch circuits, controllers, outlets and receptacles.

Complete electrical distribution system for lighting, including feeders, transformers, protective devices, panels, branch circuits, controllers, switches and outlets.

Complete emergency electrical power sources and controls.

Complete emergency exit and exterior lighting systems, including luminaires, lamps, controls, and supports.

Special purpose systems.

Fire and smoke detection and evacuation alarm systems.

Interior communications systems.

General and special usage and reproduction systems.

Temporary construction power and lighting.

9. Plumbing

Domestic hot and cold water systems.

Waste and vent systems.

Storm drainage system.

Plumbing fixtures.

Sterilization.

Fire protection systems.

Temporary construction water and waste systems.

10. Elevators and Lifts

Complete elevator and lift systems, including cabs, hoisting and driving mechanisms, safety provisions, signal and alarm systems.

Temporary hoisting during construction.

11. Heating, Ventilating and Air Conditioning

Hot water station, including heat exchangers, pumps, controls, and alarms.

Hot water distribution system, including piping, insulation, terminal units, and controls.

Ventilation systems, including corridors, suites, kitchens, and meeting spaces.

Exhaust systems, including toilets and special exhausts.

Temporary construction heat.

12. Electrical Services

In addition to the usual systems described above, the electrical concept for the Enclosure will be designed to provide several unusual but necessary features.

General Lighting: There are some 60,000 square meters under the Enclosure containing more than 2,550,000 cubic meters. The terrain will have hills, valleys, water courses, heavy and light planted areas, pools, tennis courts, and other recreational features, walkways, support structures, restaurants, and shopping facilities, meeting areas, and in all, a variety of vistas and ambiences. The roof fabric will vary from some minimum height, say five meters (16 feet) to as much as 75 meters (246 feet) above the ground. To accommodate this diverse range of lighting applications we will use an imaginative approach to the entire scheme. The general lighting intensity would be similar to what is usually experienced in a sedate garden at twilight in a more southerly geographic position. Lighting will be decorative to enhance the aesthetic ambience.

Plant Lighting: We will provide lighting to maintain and stimulate plant growth to the extent power availability, budgets, and plant life requirements allow. Certain plants require 250 foot-candles or more of artificial illumination to maintain growth. To achieve this level of intensity poses numerous aesthetic and electrical lighting distribution problems. We will study the different landscape arrangements, architectural intentions, and ecological-biological conditions in developing plant lighting schemes which should result in beneficial plant life-cycle effects and low maintenance.

Special Lighting: We will provide high levels of illumination for sports and recreational functional areas as the situation requires. Places of assembly, including amphitheatres, restaurants, shops, and so on, will be treated individualistically to suit the special needs and to create the desired theatrical or dramatic effects.

Distribution: Underground feeders as well as pole-mounted distribution lines will be used to provide a flexible and economical electrical distribution network over the enclosed area. Luminaires will be set in the ground, on poles and on structures as deemed proper for the usage.

13. Heating, Ventilating and Air Conditioning

The HVAC design will provide an all year round temperature of between 21 degrees Centigrade (70 degrees Fahrenheit) and 24 degrees Centigrade (75 degrees Fahrenheit) with relative humidities of 40 to 50 percent. The exterior design temperatures are relatively mild, varying from -5 degrees Centigrade (23 degrees Fahrenheit) in winter to 14 degrees Centigrade (57 degrees Fahrenheit) in summer. Thus, it is possible that heating may be required for much of the year.

The range of temperatures and relative humidities, coupled with lighting, will sustain plant life.

Our approach is to create the interior environment by either heating or cooling large quantities of air and circulating these quantities in such a manner as to maintain a gentle breeze throughout the Enclosure. Ringing the perimeter of the Enclosure will be some 50 air handling units, each moving about 47.2 cubic meters per second (100,000 cubic feet per minute) of air. Of this amount, about 25 percent will be fresh air as a minimum quantity during winter and 100 percent during the summer. In the interior sections of the Enclosure another 30 to 50 air handling units will circulate almost the same amount of total air, but with no fresh air intakes. Thus, a total of 4720 cubic meters per second (10 million cubic feet per minute) will be moving within the space, giving the equivalent of six air changes per hour.

The support structures for the Enclosure will house exhaust fans which will expel air in the same quantities as the air handling units are bringing in fresh air. There will be additional fans located at the upper ring of the Hotel and at other selected points throughout the Enclosure to handle special conditions. Smoke and excessive heat vents will also be strategically placed.

During winter, the air handling units will pass air over hot water coils to temper outside air and to bring recirculated air to temperature levels that will satisfy heat losses.

During the warmer seasons, outside air will be used to modulate recirculating air temperatures to satisfy internal conditions. Our analysis indicates that heat gains through the roof and sidewalls and internal heat gains from lighting and other sources can be offset by using outside air as the cooling medium so that there will be no requirements for a large refrigerating plant. Special facilities within the Enclosure may require local refrigeration which will be accomplished by means of relatively small direct expansion refrigerant systems.

By careful design techniques we anticipate that the same approach will also apply to the Hotel. That is, we will use hot water for heating nearly all year round. During the mild seasons and for special function rooms that may require cooling, outside air will be used as the cooling medium for the most part. Where necessary, relatively small direct expansion units will be used.