

AN APPLICATION OF PERFORMANCE BASED CONCEPTS AT THE STRATOSPHERE TOWER, LAS VEGAS NEVADA

By:

James R. Quiter, P.E., Senior Vice President
Rolf Jensen & Associates, Inc.

INTRODUCTION

This paper discusses the performance based approach to fire protection that **was used** at the Stratosphere Tower in Las Vegas, Nevada. It includes a description of the building, some of the problems faced, the analyses conducted and the solutions proposed and implemented. The building is now open and occupied, and is a major new landmark on the Las Vegas skyline.

The Stratosphere Tower **is** the tallest free standing observation tower in the United States. It **is** **1,149** feet high. It contains several occupied floors including wedding **chapels, function** rooms, restaurant and lounge, and observation levels. At the top are two **ride** levels, which include an outside roller coaster and the Space Shot. Figures 1 **and** 2 show typical floors of **the** tower.

This paper identifies many of the problems that needed to be resolved in the design of the tower. However, it concentrates on the solutions used for evacuation **of** the building.

ISSUES TO BE ADDRESSED

In developing the fire protection program for a building such **as** the tower, there are many issues that had to be addressed. The most obvious issue **is** how to evacuate the building. The lowest occupied floor is 795 feet above grade. The area of the shaft is not large enough to provide remotely located stairs, and the height of the building makes the use of stairs **as** an evacuation route **a less** than perfect solution.

A second problem **was** how to determine the occupant load in the tower, and how to limit that load.

Third, the height of the tower had to be considered in evaluating fire fighter access and methods.

Fourth, each utility, **be** it fire protection or other utilities, had to be specifically evaluated to assure reliability and safety. This includes all of the typical fire protection features such **as** water supply, fire alarm, **smoke** control, and emergency **power**. It also includes protection of gas lines that serve cooking equipment in the tower and use and shut-down of the rides at the top of the tower.

Lastly, the program needed to evaluate exposures to the tower from the structure below. **The** tower rises above a casino building and the impact of a fire in the casino had to be evaluated.

THE EXIT PROGRAM

As stated previously, the tower presented specific problems with relation to evacuation of the building. Because some floors of the building may include occupancy **by** more **than 500** people, strict code application would require three exit stairs leading from **the** top of the tower to the base of the building. However, **as with** other observation towers, the shaft of the structure is not large enough to contain three exit stairs. Even with multiple **stairs** in the shaft, separation of those **stairs** would be impossible. Therefore, an alternate method of evacuating people was developed.

The primary evacuation method for this building is the use of typical exit stairs for the occupied floors discharging to areas of refuge on the lowest two floors of the pod. In other words, from Floors 3 through 10 of **the** pod, three exit stairs are provided, enclosed in 2-hour construction, just **as** would be found in any other building. However, these stairs discharge to an area of refuge at the lowest two levels of the pod, which is still **750** feet above grade. These two areas of refuge are used for no other purpose, and are completely non-combustible. Rather than rely on mechanical systems to **maintain** them free of smoke in the event of fire, the two areas of refuge are open to outer **air** so that natural ventilation of these levels occur. Since the two areas are below the occupied levels, it is unlikely that fire in an occupied level would spread to the areas of refuge. With all the other fire protection systems provided, the possibility of fire spread is virtually eliminated. **See** Figure 3 for a layout of one of the areas of refuge levels.

From the area of refuge, a single stair leads down through the shaft of the tower to grade. The primary evacuation route from the area of refuge involves the elevators. These elevators are two-level elevators which travel at 1,800 feet per minute and can discharge either within the **main** casino or at two specially designed discharge levels at **the** roof of the base building. These discharge levels are enclosed in two-hour construction **from** the roof to grade, **and** are separated from all other areas by two-hour construction.

SPECIAL ELEVATOR PROTECTION

In order to assure **safety** of the elevators, special protection was provided in the building. This building design was occurring during **many** of the **NIST** studies regarding use of elevators for evacuation in buildings. **Many** of the **NIST** recommendations, that were

developed in symposiums and through research on the use of elevators, were incorporated into this design. Some of these include the following:

1. Elevators open into two-hour elevator lobbies on all floors, both at the top and at **the bottom** of the building.
2. There are four elevators which travel through the shaft **from** the base to the top. These elevators are served **by** two independent elevator machine rooms. The elevator machine rooms are separated by two-hour construction and have a 4-inch curb installed between them **so** that waterflow in one machine room will not impact **the** other machine room.
3. Elevator lobbies **are** on a separate smoke control system to **maintain** pressurization **with** relation to adjacent spaces. Therefore, fire in an adjoining area will not spread smoke into the elevator lobby.
4. Openings into the elevators are slightly raised from the remainder of the floor. Therefore, water **flow** on a floor level will not spill into the elevator hoistway because of the raised **entry**.
5. Because the areas of refuge are at the two lowest levels of the **pod**, the elevators will not need to travel past a fire floor. Elevators will travel **only** between the areas of refuge and the base building. **NOTE:** Areas of refuge for disabled persons **are** provided within the enclosed pressurized stairwells at each level.
6. Elevator shafts are vented to the outside at the top and the vents are separate **from the** machine rooms. In addition, the machine rooms **are** on separate smoke control systems and **air** conditioning for the machine rooms is on emergency power.
7. All four elevators are on emergency power. The emergency **power** riser is in a separate dedicated 2-hour shaft.
8. **Only** three of the elevators are assumed to be available for evacuation purposes. The fourth elevator is dedicated for use by the fire department.

STAIRS

In addition to **the** elevator evacuation, a **single** stair leads down through the tower and **discharges** to grade. This stair enclosure is pressurized, and remains independent of the base building. The stair enclosure **has** periodic enlarged landings, **which** will allow

occupants to stop and rest **as** the descend ~~through~~ the building. In addition, the three stairs in the **pod** of the building are enclosed in 2-hour construction and pressurized. Each of these stairs has areas of evacuation assistance, with **communication** capability to the **central** control room.

OCCUPANT LOAD DETERMINATION

With **a building** of this type, it is important to understand and control the occupant load. Three methods were used to determine occupant load. Once the three calculations were performed, **the** lowest occupant load calculated is used **as** the limiting factor for the building. These three methods are **as** follows:

1. Building codes typically allow holding **areas** or areas of refuge for horizontal exits. Where those holding areas are used, the code requires **a minimum** of 3 **square** feet per person for holding area. Therefore, one of the limiting factors for **this** building **was** the size of the areas of refuge. The areas of refuge were calculated at one person per 3 square feet to determine their **maximum** holding capacity. This provides a factor of safety for several reasons:
 - a. The area of stairs leading to the areas of refuge **was** not included in the holding area. These stairs would significantly increase the number of people that can be safely accommodated within an area separated from the fire by 2-hour **construction**.
 - b. The calculations assume that no **occupants** are leaving the building via elevator or stair. Instead, they assume that all occupants are contained within the areas of refuge.
 - c. The evacuation **scenario** is to evacuate the floor of origin, the floor above, and the floor below. Therefore, **only** a portion of the building will be simultaneously evacuated. However, the occupant load of the entire building is limited by the size of the area of refuge.
2. The second means of limiting the occupant load of the building **was** based on code calculations. The expected occupant load, based on Table 33-A of the Uniform Building Code, **was** calculated for each floor of the building. The load was then totaled for the entire building and this occupant load is used **as a** limiting factor for the number of people in the building.

- 3.** The third limiting factor is the capacity of the elevators to evacuate the people. The speed of evacuation **was** based upon **NIST** studies which contain calculation methods for elevator evacuation. In this project, it **was** concluded that a 1-hour **time** frame **was** a reasonable time to fully evacuate the areas of refuge. **This** 1-hour **time** frame **was** based on three of the four elevators being used for evacuation, with the fourth dedicated solely to fire department use. The 1-hour calculation **also** ignores the availability of **the** stair leading down through the shaft. Therefore, by **this** calculation, all occupants are expected to leave via the three elevators. **NOTE:** Operational considerations require the occupant load to be further limited if one of the elevators is **down** for repair.

Once these three methods of calculations were completed, an occupant load of approximately 2,600 people **was** developed **as** the expected load of the building. This was the load factor **around** which the remainder of the building **was** designed. In order to be confident that this load factor is not exceeded, the building owner has instituted an occupant counting system which keeps track of the number of people entering and leaving the tower. Therefore, the load of the building will not exceed the calculated occupant loads.

OTHER FEATURES

The evacuation system for this building cannot stand alone. The fire protection features for this building were specifically designed to rapidly detect and suppress a fire, **and** control smoke generated by the fire. Some of the other features provided within the building are **as** follows:

Automatic Sprinklers - The building is completely protected with automatic sprinklers. Sprinkler densities exceed those required by the codes. The sprinkler system was calculated to provide a very **high** density for the first four sprinklers operating, plus ordinary **hazard** density for the most remote 1,500 square feet.

Water supply is from two pumps at street level which pump up to the pod. There is on-site water storage **within** the pod and two additional pumps sized for sprinkler plus standpipe demand in the pod. With these pumps **and** on-site water storage, redundant water supply is available.

Detection and Alarm - The building is fully protected with automatic smoke detectors, except that kitchens contain heat detection. The smoke detectors are on an addressable system, with **alarm** verification to reduce the number of unwanted alarms. Manual pull

stations are **also** provided in the facility. In order to reduce unwanted pull station alarms, the **manual** pulls have been placed within the stairways.

The alarms report to the **main** central control room for the Stratosphere Casino, **as** well as two auxiliary control rooms. **One** of the auxiliary control rooms is located at the base of the tower, and the second is located within the **area** of refuge at elevation **750** feet. The **control** room within the area of refuge is accessed directly **from** the fire fighters elevator. Communication and information flow **from** the three control rooms is identical.

The fire alarm system is a **Class A** system, with separate risers **running** up through the **shaft**. The risers are separated by 2-hour construction.

Emergency Power - Emergency power is sized to accommodate all portions of the fire protection system. This includes the fire pumps, fire alarm system, all elevators, smoke control and necessary lighting. The emergency power riser is routed **through** a separate 2-hour **shaft** up through the tower in order to prevent a single event **from** impacting the primary and emergency power.

Smoke Control - The building is provided with an automatic smoke control system. **Upon** actuation of an alarm, the floor or origin and any floors open to it go to full exhaust while adjoining floors are pressurized. **In** addition, the elevator lobbies for all floors are pressurized, **as** is the stair leading down through the shaft of the tower. Exhaust from **the** smoke control system is ducted to discharge above the ride level at the top of **the** tower in order to eliminate reintroduction of smoke into the building.

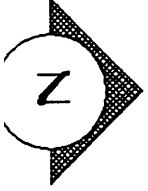
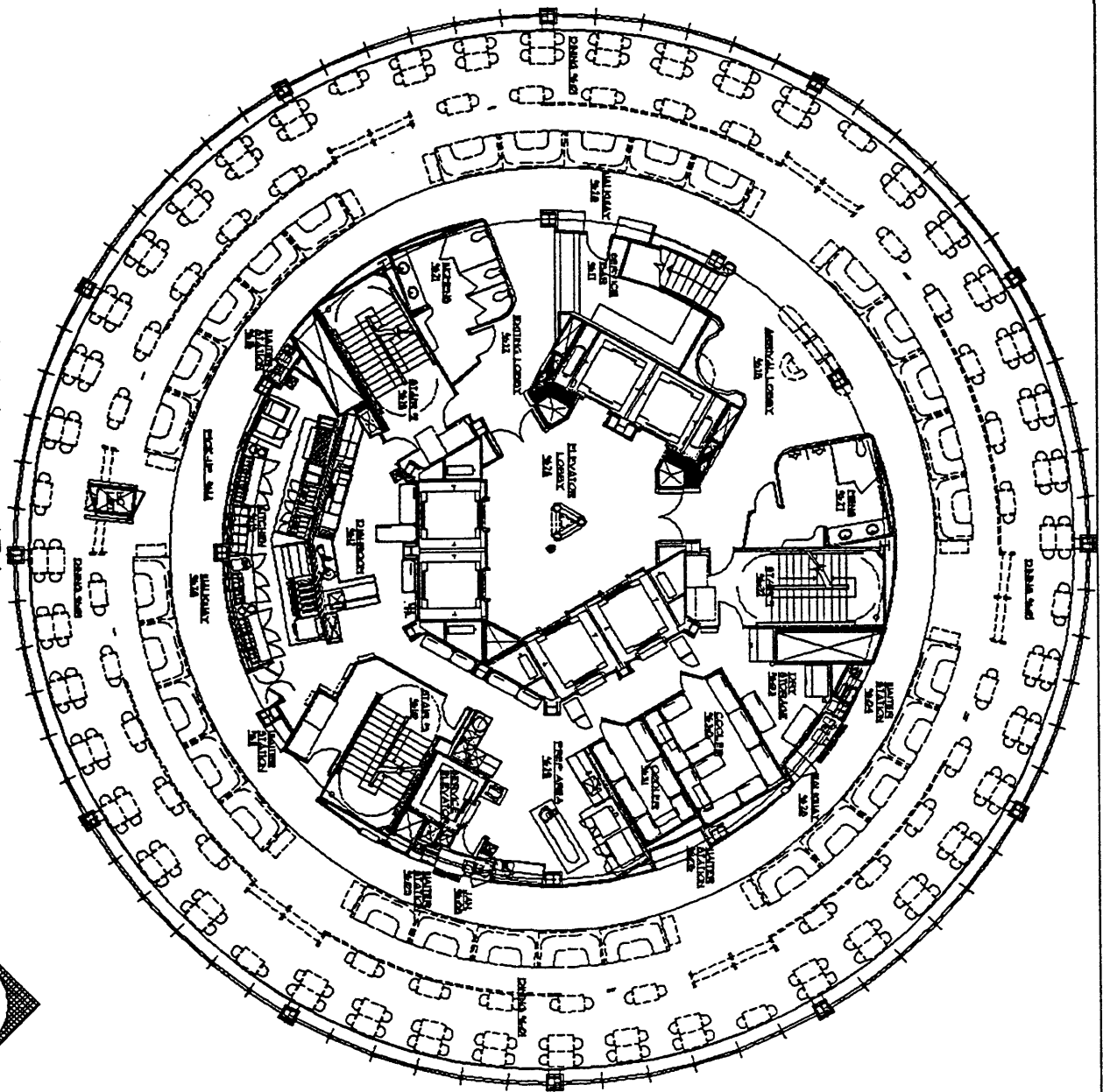
CONCLUSION

The Stratosphere Tower provided an opportunity and a need to develop a fire protection approach which departs from the typical building code approach to a building. Use of **stairs as the** sole evacuation method **was** not feasible or reasonable. Requiring all of the occupants to **utilize** stairs would result in **an** unsafe condition for many of **the** expected **occupants** of this building. A more reasonable method **was** to provide an area where people could be staged until evacuated, and a reliable means to perform that evacuation. The approach, **as** briefly described in this paper, provides protection in accordance with the overall intent of the building codes, while departing significantly **from the** detailed requirements of code. Therefore, this is a true application of performance based approaches to fire protection in a building.

JRQ:dp

FIGURE 1

1 Level 6 Floor Plan
 Floor Plan +832'-0"
 SCALE 1/8"=1'-0"



A2.08		Sheet Title LEVEL 6 FLOOR PLAN	STRATOSPHERE TOWER FOR STRATOSPHERE CORPORATION	<p style="font-size: small;">A.C.T. Architects, Inc. 2500 Las Vegas Blvd. Las Vegas, Nevada 89104</p> <p style="font-size: x-small;">Drawings and specifications remain the property of the design professional. Copies of the project and modifications retained by the client may be used only for the use and for executing the project for which they were prepared, and not for construction for any other project.</p>
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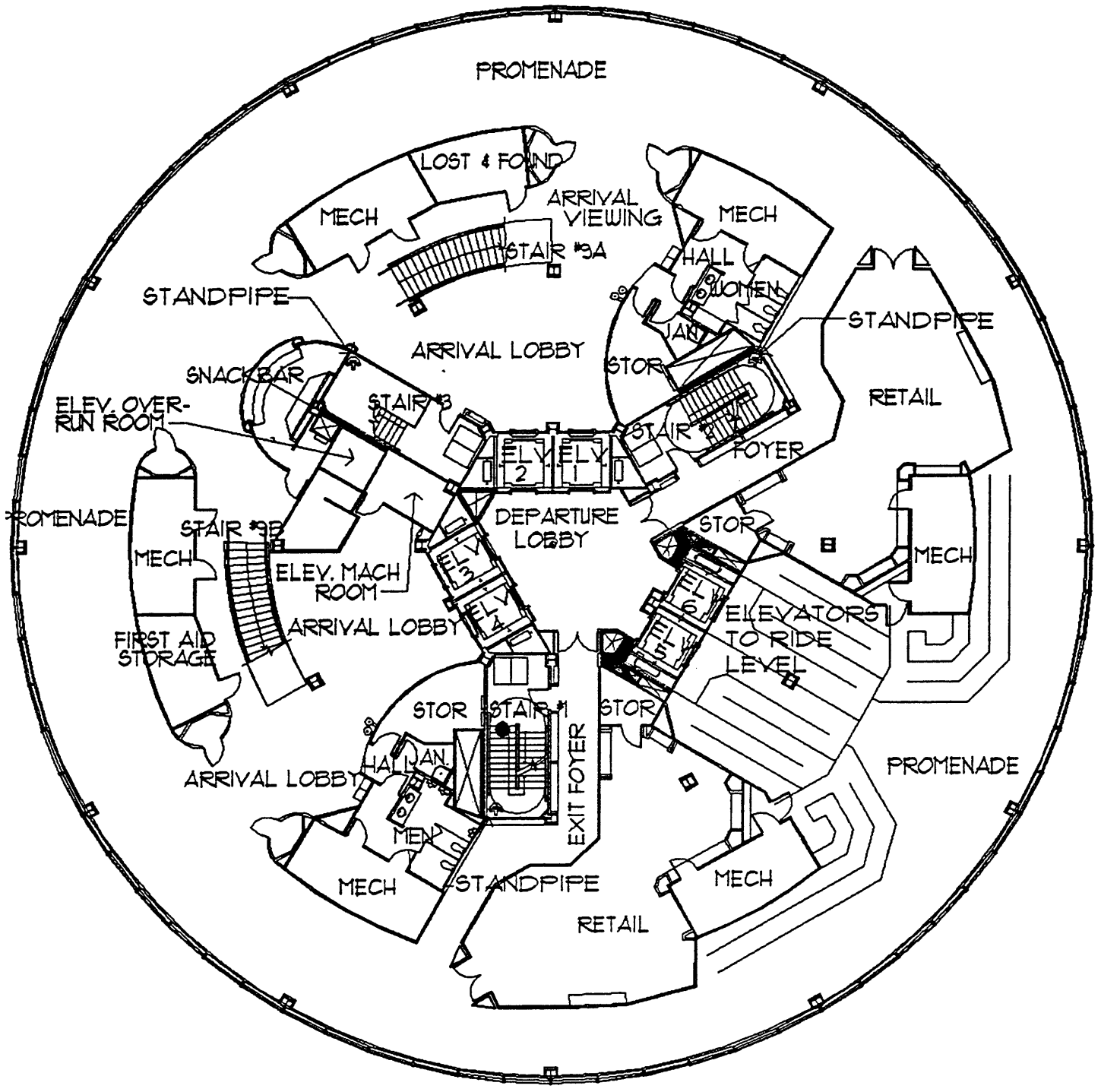


FIGURE 2

● - YOU ARE HERE

STRATOSPHERE TOWER
Level #108 Floor Plan

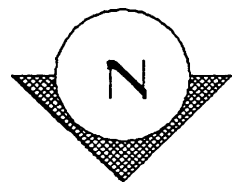
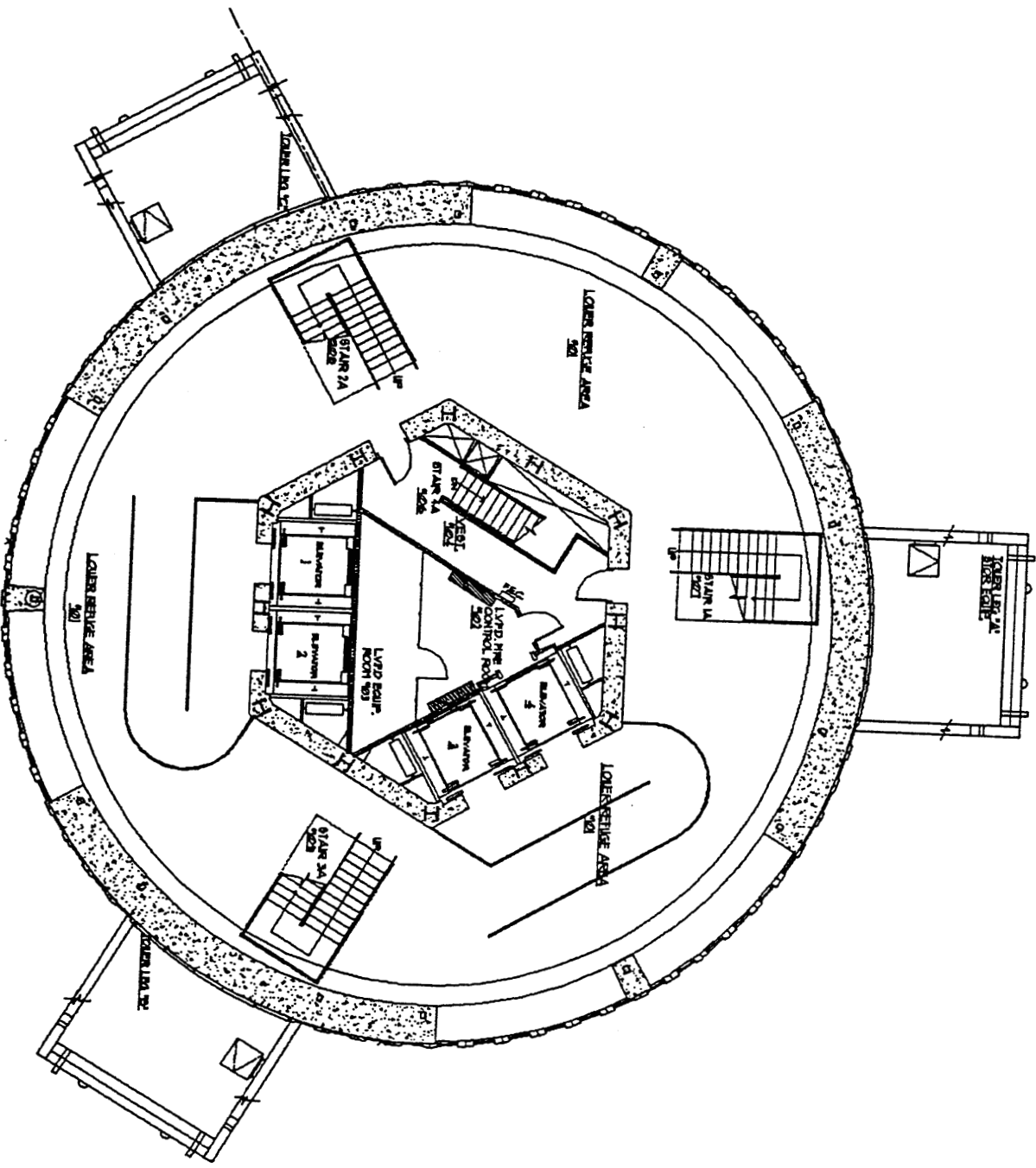


FIGURE 3

Level # Lower Refuge
 Floor Plan + TTB'-0" SCALE 1/8"=1'-0"



A2:01		<p>Sheet Title LEVEL 1 LOWER REFUGE</p>	<p>STRATOSPHERE TOWER STRATOSPHERE CORPORATION</p>		<p>Scale: 1/8"=1'-0" Date: 10/15/84 Drawn: J. Smith Checked: M. Jones</p>
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