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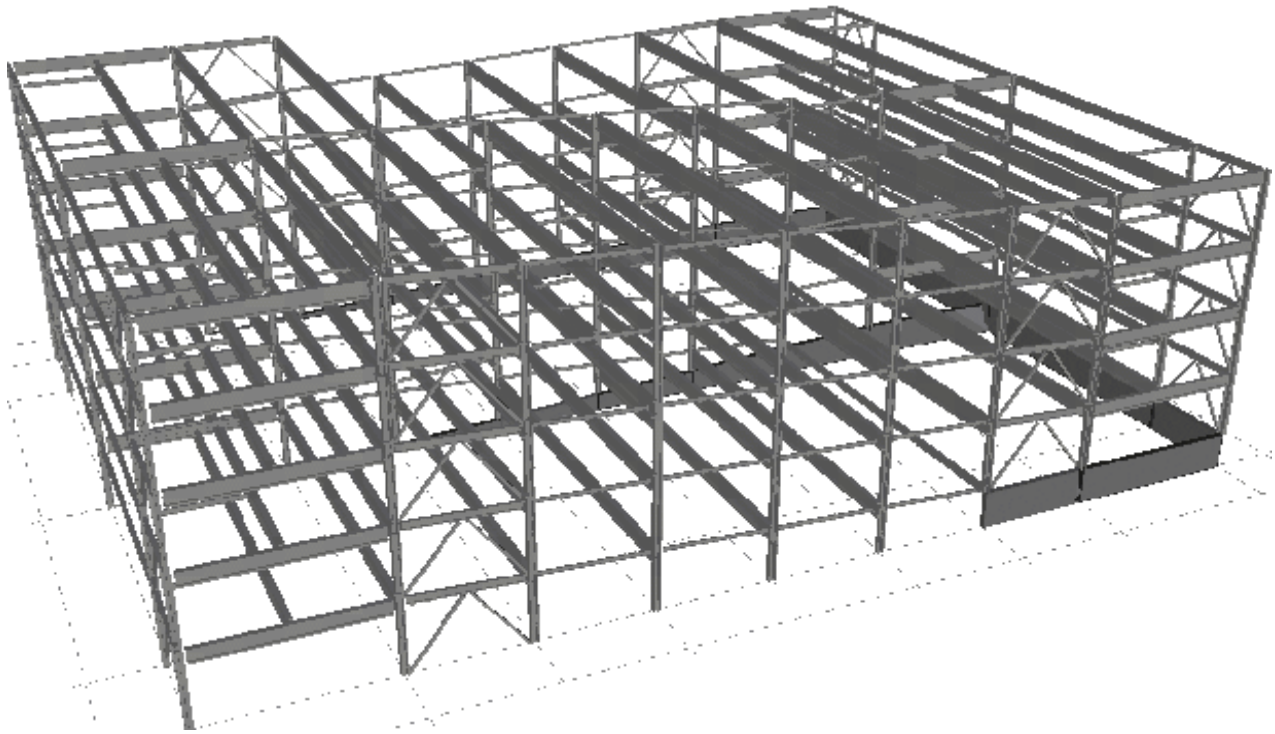
THE PARKING STRUCTURE PROTOTYPE I



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THE PARKING STRUCTURE PROTOTYPE I

Prepared by: AISC Steel Solutions Center

What's this?

This package contains a fictitious project with an imaginary client. It illustrates the type of information that the AISC Steel Solutions Center (SSC) typically receives and the Conceptual Solution that might be prepared in reply. It is important to note that the information comes with the continued involvement of the Steel Solutions Center and more directly AISC's Regional Engineers. Together, we are committed to developing efficient, economical solutions in steel and providing continuous support for the life of the project.

Incoming:

A project can find its way to the Steel Solutions Center a number of ways. Common scenarios include:

1. AISC may hear about the project while visiting an architect or engineer's office and cold-call the developer to find out more.
2. A general contractor is asked to provide budget numbers for a project designed in concrete. They see an opportunity to save money using a steel frame and take the project to their favorite fabricator. The fabricator agrees to put together a steel alternate and calls the SSC for help.

The Solution:

The AISC team and the client work together—often via conference call—to determine what can be done to move the project forward in steel. The Steel Solutions Center can provide a wide range of solutions from a simple bay study to a lateral system analysis, foundation comparison and conceptual estimate. A unique Conceptual Solution matching the detail of this prototype would represent the SSC's highest level of response.

What now?

The Prototype is one example of the Conceptual Solutions the SSC can provide. More importantly, because it is representative of many real steel parking structures, it can be the first step in moving the project forward in steel. Many SSC clients have found this Prototype alone can capture the developer's attention.

The Steel Solutions Center has been involved in a broad range of projects since our inception in 2001. In addition to parking structures, we can help you find innovative solutions for high-rise offices, multi-story residential buildings and more.

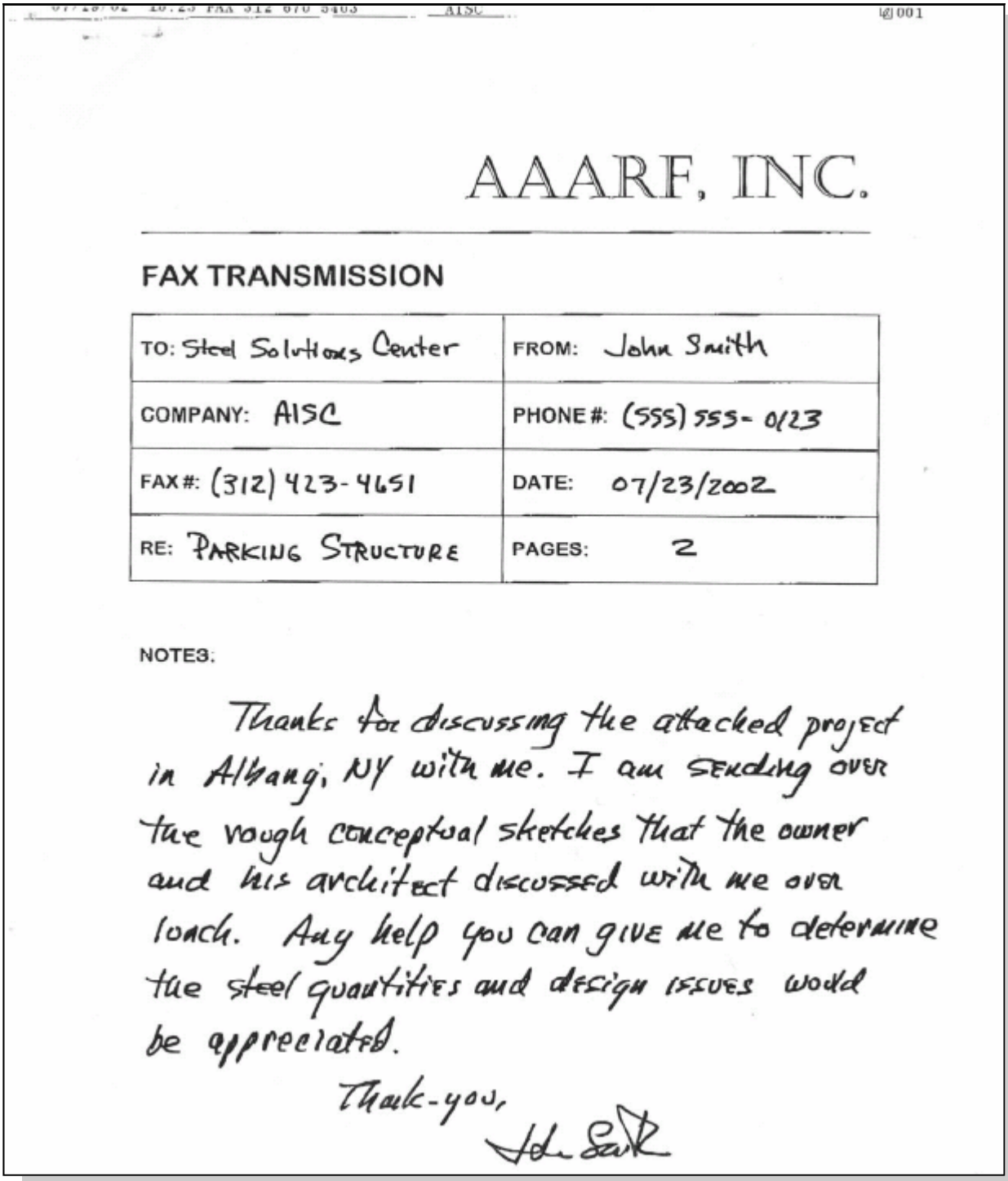
It is important to us to meet the expectations of the people we work with. The last two pages communicate what our clients can expect from the Steel Solutions Center and what the SSC expects from our clients. Remember the Conceptual Solution is only the beginning. The AISC team will continue to provide assistance for the life of your project.

Please let us know how we can assist you with your next project.

The incoming fax...

Page 1 of 2

Incoming:
John Smith saw a Steel Solutions Center ad in Modern Steel Construction and sent an e-mail to the SSC. Gene Martin, the Regional Engineer for the Upper Midwest, contacted John to discuss the project that afternoon. As a result of the conversation John sent a fax to the SSC, which is included in the next two pages.



AISC 001

AAARF, INC.

FAX TRANSMISSION

TO: Steel Solutions Center	FROM: John Smith
COMPANY: AISC	PHONE #: (555) 555-0123
FAX #: (312) 423-4651	DATE: 07/23/2002
RE: PARKING STRUCTURE	PAGES: 2

NOTES:

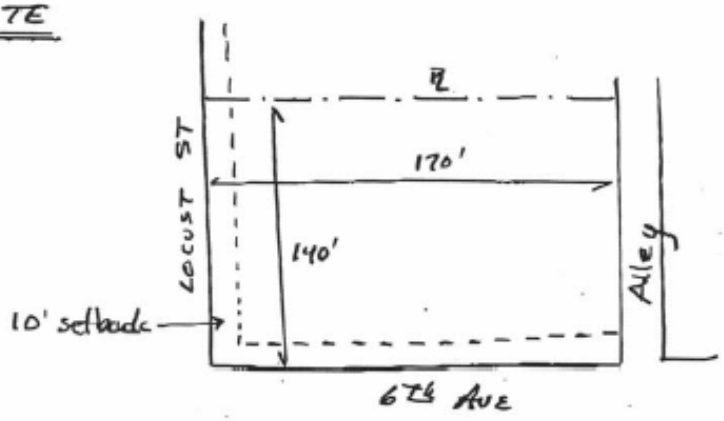
Thanks for discussing the attached project in Albany, NY with me. I am sending over the rough conceptual sketches that the owner and his architect discussed with me over lunch. Any help you can give me to determine the steel quantities and design issues would be appreciated.

Thank-you,

John Smith

The incoming fax...

SITE

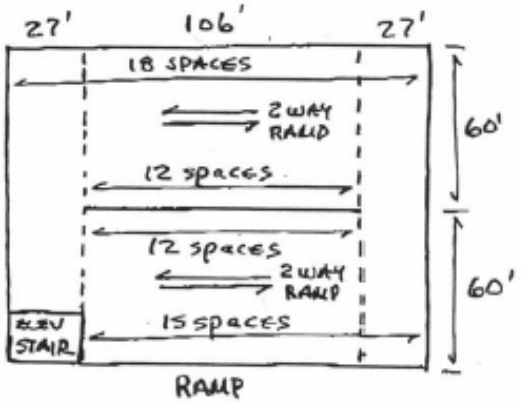


Requirements = space for 275 cars.

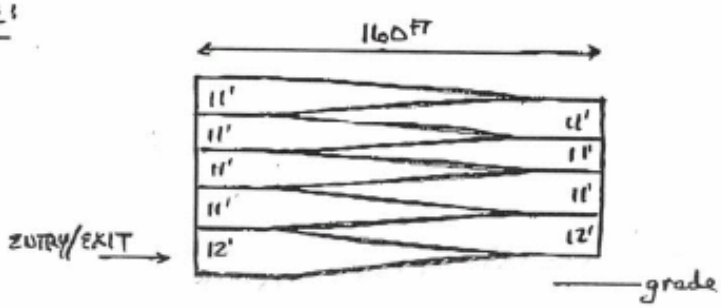
ARCHITECT'S SUGGESTION:

Typical Floor:

1 space = 8.75'



Profile:



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THE PARKING STRUCTURE PROTOTYPE I

Prepared by: AISC Steel Solutions Center

The Solution:

After receiving John Smith's fax, the Regional Engineer, an SSC advisor and John participated in a conference call to qualify the project. The project was in Gene Martin's territory making him the Regional Engineer in charge of the project. Here's what the AISC team learned from the conversation:

John had a meeting with the owner in 8 days

The owner had some reservations, but was open to a steel framed structure.

The owner was concerned about fireproofing requirements for a steel structure.

The owner will operate the parking garage and was very interested in life-cycle costs and security for the users.

The site has poor soil conditions.

After reviewing all the information at hand, the AISC team agreed that a steel alternative could meet the owner's needs and provide cost savings up front and over the life of the project. We also agreed that influencing the owner would require the SSC's highest level of response, including a preliminary structural design performed specifically for this project, a review of current building codes for fire protection requirements and an examination of the foundation load reduction that a steel structure would offer over the concrete alternative.

The Outcome:

Using the Conceptual Solution as a starting point, John Smith drew on his expertise to estimate the cost and schedule for this project. John asked Gene Martin to join him at the meeting with the owner, hoping to capitalize on Gene's expertise and experience in dealing with construction professionals. They prepared a presentation for the owner to highlight the following key advantages of a steel structure:

- Lighter foundation loads translate to cost savings.
- A higher level of security is achieved with the more open steel structure. Steel framing replaces shear walls with open diagonal bracing and reduces the column thickness significantly thereby eliminating possibly dangerous dark areas.
- A post-tensioned slab and a steel frame with a quality paint system or galvanizing combined with regular a maintenance program provides for the lowest life-cycle cost of owning and operating the parking structure.

The savings in both time and money caught the owners attention. John and the Gene addressed the owner's fireproofing concerns backed by the data provided in the Conceptual Solution. The $2 million savings in foundation costs due to the lighter steel frame put it over the top and the owner decided to pursue a steel parking structure. A success for the fabricator!

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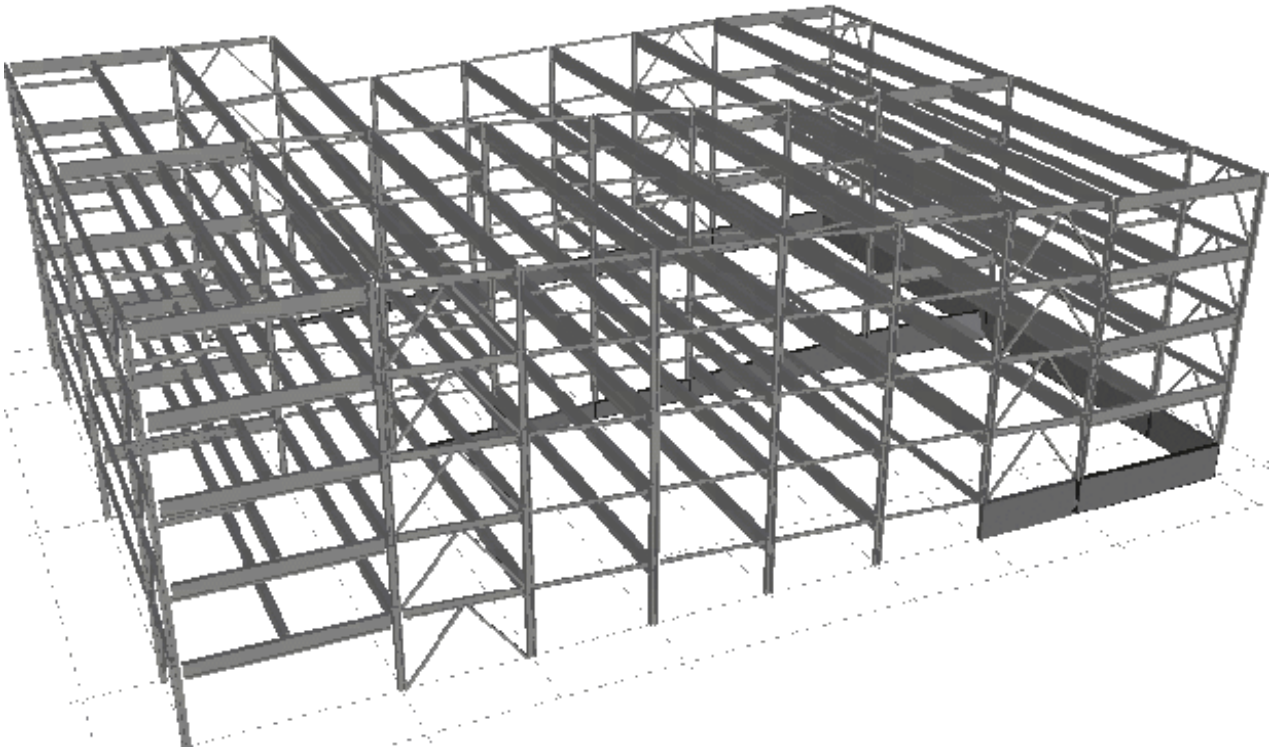
THE PARKING STRUCTURE PROTOTYPE I

SSC Advisor: Jason Ericksen
Regional Engineer: Gene Martin
Date: July 30, 2002



This Package includes:

Comments on the Provided Solution	
Steel Quantity Takeoff	
Design Loads and Parameters	
Typical Floor Framing Plans	North Levels
	South Levels
Gravity Columns	Layout
	Schedule
Braced Frame Elevations	Frames #1 and #2
	Frames #3 and #4
Fireproofing Evaluation	

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COMMENTS ON PROVIDED SOLUTION

Project:	**Parking Structure Prototype I**	Date:	**July 30, 2002**
Location:	**Albany, NY**	SSC Advisor:	**Jason R. Ericksen**
Client:	**AAARF, Inc.**	Client Contact:	**John Smith**

- The design criteria per IBC 2000 is summarized and included in the following pages. The Steel Solutions Center has also provided an overview of fireproofing requirements for open parking structures for IBC 2000 and NFPA 5000. The project has four open sides and proper separation from adjacent buildings. Therefore, it is demonstrated that fireproofing is not required for the structural steel for this project.
- The steel quantities and geometry are provided on floor layouts, a column and frame layout plan, a column schedule and frame elevations. The floor framing is split into two typical levels, North and South. Both plans include the horizontal steel at that level and the steel on the ramp down to the next level. The North framing plan occurs five times on the project. The South framing plan occurs four times. The lowest level of parking on both the north and south ends of the structure is slab-on-grade. The typical floor system is a 5 ½" post-tensioned, normal-weight, shored concrete flat slab with composite steel beams perpendicular to the one-way slab action.
- A post-tensioned concrete flat slab system provides the required durability to resisting de-icing salts and as such is the best solution for this region of the country in terms of life cycle costs.
- The lateral force-resisting braced frames do not require moment connections. The column splices may need to transmit tensile forces, which may require special detailing. The frame elevations indicate all of the structural steel in the lateral force-resisting system.
- The foundation loads were examined and compared to a comparable concrete system. The steel structure saves 25% in the total foundation loads for the structure.
- Material Specification

  Wide flange shapes are A992, Gr. 50

  Rectangular HSS sections are A500 Gr. B

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QUANTITY TAKEOFF SHEET:

Post-Tensioned Slab on Steel

Project:	**Parking Structure Prototype I**	Date:	**July 30, 2002**
Location:	**Albany, NY**	SSC Advisor:	**Jason R. Ericksen**
Client:	**AAARF, Inc.**	Client Contact:	**John Smith**

Slab-on-Grade:

12,840 ft^2 Parking (36 spaces)

Suspended Floor Areas:

89,955 ft^2 (89,950 ft^2 of parking with 255 spaces)

Steel Quantities:

Gravity Columns				
W12's		26.0 tons	0.58 psf	30 pieces
Beams (gravity)				
Wide Flange		318 tons	7.07 psf	144 pieces
3,200 studs				
Columns (braced frames)		26.3 tons	0.58 psf	32 pieces
Beams (braced frames)		8.9 tons	0.20 psf	36 pieces
Braces (braced frames)		11.2 tons	0.25 psf	72 pieces
Miscellaneous	10%	39 tons	0.9 psf	
		429tons	**9.5psf**	**314pieces**

* The quantities are based on centerline dimensions

** Miscellaneous steel accounts for framing not included in the model, such as framing for openings. It does not include connection material or slab edge material.

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DESIGN PARAMETERS:
International Building Code 2000

Project:	**Parking Structure Prototype I**	Date:	**July 30, 2002**
Location:	**Albany, NY**	SSC Advisor:	**Jason R. Ericksen**
Client:	**AAARF, Inc.**	Client Contact:	**John Smith**

Gravity Loads

Live Loads	Uniform	Concentrated
Parking	50 psf	2 kips
Stairs	100 psf	0 kips

Roof Live Loads	Uniform
Ground Snow	40 psf

Partition Loads (SDL)	Uniform
Parking	0 psf
Stairs	0 psf

Dead Loads

Post-Tensioned Flat Concrete Slab =	5.5 in
Concrete Density =	145 pcf
Floor System Weight =	66 psf

Cladding Loads	Uniform	Floor Height	Cladding Load
Precast Panels	50 psf	6 ft	300 plf

Wind Load Parameters

Basic Wind Speed =	110 mph
Wind Importance Factor, I_W =	1.00
Exposure Category =	B
Topographical Factor =	1.00
Drift Limit =	H/400

Basic Seismic-Force-Resisting System

Ordinary Steel Concentrically Braced Frame

Seismic Design Parameters

			X-axis	Y-axis
Seismic Use Group =	I	Building Period Coefficient, C_T =	0.020	0.020
Seismic Importance Factor, I_E =	1.00	Response Modification Coefficient, R =	3.0	3.0
Seismic Design Category =	C	System Overstrength Factor, Ωo =	3.0	3.0
Site Class =	D	Deflection Amplification Factor, C_d =	3.0	3.0
Spectral Response Acceleration at Short Periods (0.2s), S_s =	0.250 g	**Note: No Seismic detailing per AISC Seismic Provisions 2002 is required**		
Spectral Response Acceleration at One Second Period, S_1 =	0.086 g			

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FIREPROOFING ISSUES:
NFPA and IBC 2000

Project:	**Parking Structure Prototype I**	Date:	**July 30, 2002**
Location:	**Albany, NY**	SSC Advisor:	**Jason R. Ericksen**
Client:	**AAARF, Inc.**	Client Contact:	**John Smith**

Code Applicability:

The year 2000 marked the release of the International Building Code, with an update in 2003, while the National Fire Protection Association 5000 code was released in 2002. Both were created as an attempt to consolidate the multiple model codes designers have been faced with over the past several decades. NFPA 5000 (6.4.2.55) specifies that all types of parking structures conform to NFPA 88A. Verification of which code is applicable for a planned parking structure should take place as planning begins.

Code Definitions:

Care must be taken in understanding the provisions of the codes based in the definition of certain terms. These include:

Height-the IBC defines the height of a parking structure as the vertical distance from the grade plane to the highest roof surface. NFPA does not define height.

Openness-the IBC defines required openness for a parking structure as having uniformly distributed openings on two or more sides of the structure comprising at least 20% of the total perimeter wall area of each tier and the aggregate length of the openings should constitute a minimum of 40% of the perimeter of the tier. Interior walls shall be at least 20% open (area) with uniformly distributed openings. NFPA defines openness as having distributed openings to the atmosphere of not less than 1.4 sq ft for each linear foot of its exterior perimeter. The openings should be uniformly distributed over 40% of the perimeter or uniformly over two opposing sides. Interior walls shall be at least 20% open (area) with uniformly distributed openings.

IBC Provisions:

Section 406.3.6 of the IBC allows a deck area of 50,000 square feet per tier to a maximum height of 8 tiers for type IIB construction if the structure fits the definition of openness, without a fire resistive requirement. This provision can be extended in one of two manners. First, unlimited deck area is allowed if the height of the structure does not exceed 75 feet and the distance from any point on the deck to an exterior opening does not exceed 200 feet. Second, if 50% of the interior wall area of the sides over 75% or more of the perimeter of the building is open and equally distributed, the area of each deck may be increased by 25% and the height increased by one tier. With 50% of the interior wall area open and equally distributed on all four sides of the structure, the area may be increased by 50% and the height by one tier. These provisions are presented in tabular form under “Code Comparison”.

NFPA Provisions:

For open parking structures as defined above unlimited deck area is allowed if the height of the structure does not exceed 75 feet and the distance from any point on the deck to an exterior opening does not exceed 200 feet.

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FIREPROOFING ISSUES:
NFPA and IBC 2000

Project: **Parking Structure Prototype I**
Location: **Albany, NY**
Client: **AAARF, Inc.**
Date: **July 30, 2002**
SSC Advisor: **Jason R. Ericksen**
Client Contact: **John Smith**

Code Comparison:

	NFPA 88A Type II		IBC Type IIB	
Fire Resistive Requirement	None		None	
Definition of Open Side	1.4 sq ft of each linear foot distributed along 40% of the perimeter		50% of interior wall area of the side	
	sq ft/tier	# of tiers	sq ft/tier	# of tiers
2 sides open	unlimited[1]	height <= 75 ft	50,000	8
3 sides open	unlimited[1]	height <= 75 ft	62,500	9
4 sides open	unlimited[1]	height <= 75 ft	75,000	9
Exception[1]			unlimited[1]	height <= 75 ft

[1]The distance from any point on the deck may not be greater than 200 ft from an open side.

Subject Project:

An open deck parking structure with four open sides (as defined under both NFPA and IBC) consisting of grade level parking and five supported levels of deck (tiers). The footprint of the garage is 160 ft by 120 ft or 19,200 sq ft per tier. The structure height is 56 ft.

Code Application:

Under both NFPA and IBC the structure falls under the 75 ft exception with all points on any deck within 200 ft of an exterior opening allowing unlimited deck area with a NFPA Type II (000) or IBC Type IIB classification. There is no fire resistive requirement for this project.

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FIREPROOFING ISSUES:
NFPA and IBC 2000

Project:	**Parking Structure Prototype I**	Date:	**July 30, 2002**
Location:	**Albany, NY**	SSC Advisor:	**Jason R. Ericksen**
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Research Findings:

Research data from actual fire occurrences over the past several decades in the US has demonstrated that for an open parking structure, non-crash vehicle fires do not result in heat build up or potential for flashover. The small percentage of area and volume of the parking structure involved in a vehicle fire (typically less than 2% of the area) allows adequate air volume in the uninvolved portion of the garage to mitigate the temperature and flashover potential of the fire. While no evidence exists of heat build up or flashover, the ventilation provided by the wall openings provides redundant protection for those concerns and tenable conditions for egress. Vehicle fires in parking structures are localized events that have not resulted in any fatalities. Further, research indicates that personal injuries in parking structure fires are rare and when they occur are generally unrelated to smoke or the fire itself.

Damage to the structural systems of parking garages as a result of vehicle fires has also been shown to be minimal. Data published in 1992 collected from 404 fire events reflected an average cost of structural damage of $191 or a total cost for all fires of $53,265. The evaluation of more recent fire events is consistent with the earlier findings.

Full scale fire tests, such as the Scranton Fire Test of 1972 and the Australia Test of 1985, conducted in open deck parking structures have indicated that temperatures reached in the structure do not approach the critical temperature of steel even in the unlikely event of multiple vehicles becoming involved in the fire.

Information regarding this research is available upon request.