Technical Assignment 1

[Arena Stage]

Washington, DC

Joni Richelle Anderson
Construction Management
Dr. John I. Messner

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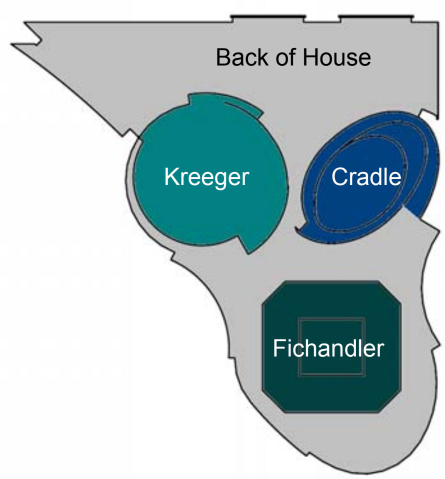
Executive Summary

This Technical Assignment takes a detailed look at the existing conditions of the renovation and expansion of Arena Stage in Washington, DC. Several aspects relating to the construction project management process will be summarized including the project schedule, cost evaluation, and the project delivery system. An overview of the building systems, local conditions, and the existing site will also be presented.

Arena Stage, owned by the Washington Drama Society, is the largest producing theatre in North America that focuses on American plays. For almost forty years, the complex's two theatres, the Fichandler and the Kreeger, have sat on the corner of 6th Street SW and Main Avenue SW. When the city launched the Anacostia Waterfront Initiative with the intent to rebuild southwest Washington, Arena Stage decided to be one of the foremost contributors and undergo a massive renovation.

Clark Construction Group, LLC was awarded the construction contract in May of 2007 for the 200,000 square foot project costing approximately $125 million. Construction began in January of 2008 with the renovation of the two existing theatres and the erection of a third, experimental black-box theatre called the Cradle. A new underground parking garage is being erected in the Back of House to provide the theatre patrons with more convenient parking. In order to bring the entire complex together, the three spaces are going to be encased in a 45' serpentine glass façade that is supported by giant, tree-like, parallam timber columns. A matrix of steel trusses forms the roof that supports a 150' metal-clad cantilever which points toward the Washington Monument in honor of the city's orienting axis.



This performing arts center is hoping to not only promote the continuation of American play writing and production, but to support a diverse workforce and provide community outreach and educational programs to the public. Arena Stage has been a monumental landmark in the community for over sixty years and in June of 2010, it will have a monumental building to match its excellence.

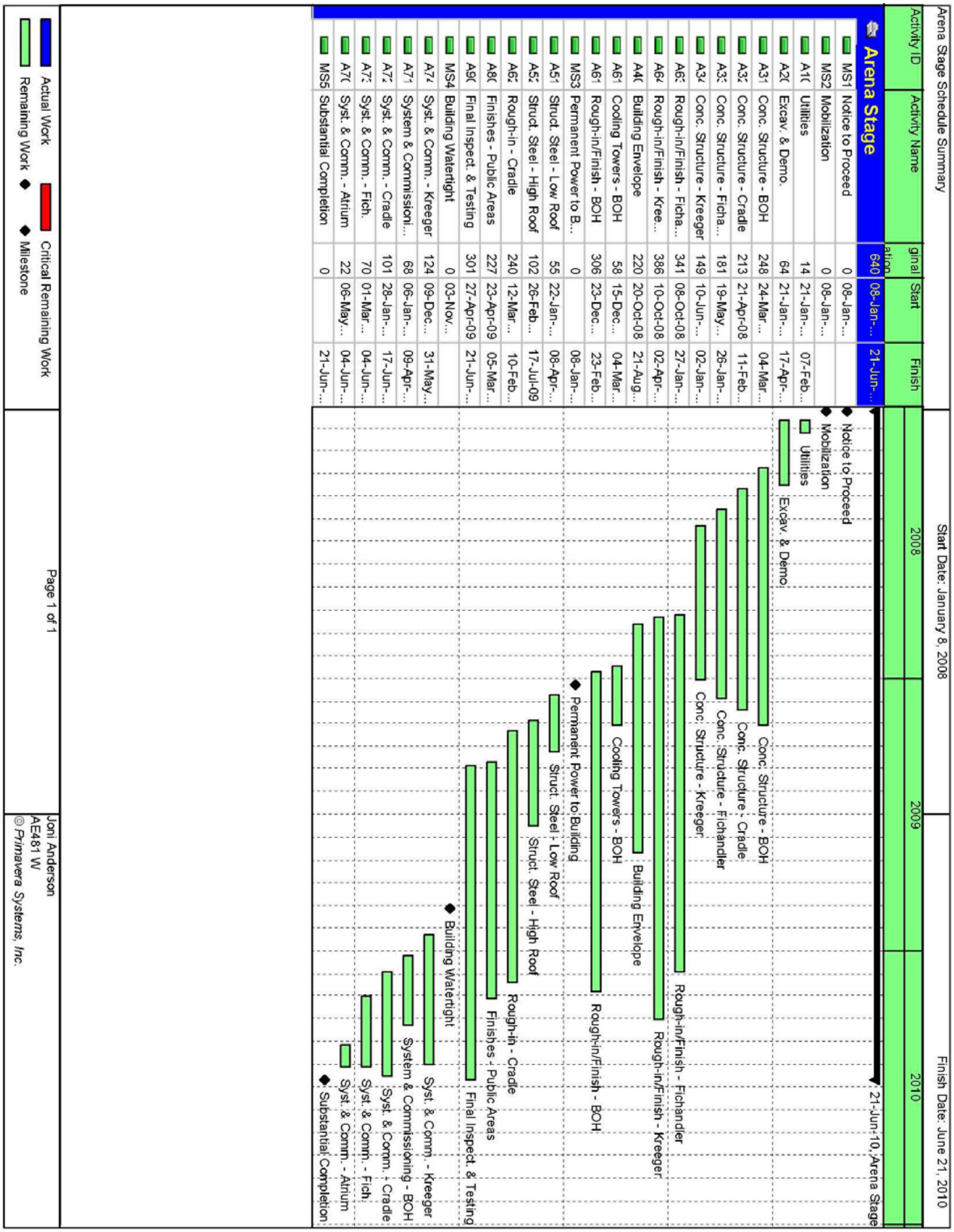
A. Project Schedule Summary

Clark Construction Group, LLC was awarded the construction contract from Arena Stage in May 2007. That gave the company 9 months to prepare for the beginning of construction, including obtaining permits. When construction started with the notice to proceed in January of 2008, the first items on the critical path were utility work, excavation, and demolition. Once permanent power was cut and temporary installed, excavation began. Underpinning and sheeting and shoring was installed on the Fichandler and the Kreeger and the piles were drilled for the Cradle foundation.

Upon completion of excavation, the concrete work began in the Back of House (BOH) and was soon followed by the Cradle. Minor concrete work in the Fichandler and the Kreeger was followed by the structural steel of the low mezzanine and high roof. The glass façade made it around the perimeter of the complex in November of 2009 and the building achieved watertight status.

Renovation of the Fichandler and the Kreeger is categorized by the MEP rough-in and finishes, which occur somewhat simultaneously. These are the longest durations on the schedule due to the massive amounts of work being done during those processes. Many other activities occur during this time including installation of major mechanical equipment and finish work in public spaces. Permanent power was installed in January of 2009.

The final inspection and testing set the stage for the systems and commissioning which took approximately 6 months for the entire project. Substantial completion is the final milestone which was reached in June 2010.



Activity ID	Activity Name	Original Duration	Start	Finish
	Arena Stage	640	08-Jan-...	21-Jun-...
MS1	Notice to Proceed	0	08-Jan-...	
MS2	Mobilization	0	08-Jan-...	
A1(	Utilities	14	21-Jan-...	07-Feb...
A2(	Excav. & Demo.	64	21-Jan-...	17-Apr-...
A31	Conc. Structure - BOH	248	24-Mar...	04-Mar...
A32	Conc. Structure - Cradle	213	21-Apr-08	11-Feb...
A33	Conc. Structure - Ficha...	181	19-May...	26-Jan-...
A34	Conc. Structure - Kreeger	149	10-Jun-...	02-Jan-...
A63	Rough-in/Finish - Ficha...	341	08-Oct-08	27-Jan-...
A64	Rough-in/Finish - Kree...	386	10-Oct-08	02-Apr-...
A40	Building Envelope	220	20-Oct-08	21-Aug...
A61	Cooling Towers - BOH	58	15-Dec...	04-Mar...
A61	Rough-in/Finish - BOH	306	23-Dec...	23-Feb...
MS3	Permanent Power to B...	0		08-Jan-...
A51	Struct. Steel - Low Roof	55	22-Jan-...	08-Apr-...
A52	Struct. Steel - High Roof	102	26-Feb...	17-Jul-09
A62	Rough-in - Cradle	240	12-Mar...	10-Feb...
A80	Finishes - Public Areas	227	23-Apr-09	05-Mar...
A90	Final Inspect. & Testing	301	27-Apr-09	21-Jun-...
MS4	Building Watertight	0	03-Nov...	
A74	Syst. & Comm. - Kreeger	124	09-Dec...	31-May...
A71	System & Commissioni...	68	06-Jan-...	09-Apr-...
A72	Syst. & Comm. - Cradle	101	28-Jan-...	17-Jun-...
A73	Syst. & Comm. - Fich.	70	01-Mar...	04-Jun-...
A70	Syst. & Comm. - Atrium	22	06-May...	04-Jun-...
MS5	Substantial Completion	0		21-Jun-...

Figure 1: Arena Stage Project Schedule Summary performed in Primavera

B. Building Systems Summary

Yes	No	Work Scope
✓		Demolition Required
✓		Structural Steel Frame
✓		Cast in Place Concrete
	✓	Precast Concrete
✓		Mechanical System
✓		Electrical System
✓		Masonry
✓		Curtain Wall
✓		Support of Excavation

Table 1: Building Systems Summary Checklist

Demolition

The existing Arena Stage consists of two theatres: the Fichandler Theatre, built in 1960, and the Kreeger Theatre, later added in 1971. Both of the structures are concrete block with steel frame and are two stories above grade with a below grade basement. Portions of the Kreeger theatre, administrative offices, and the connecting building were razed prior to the beginning of the new construction. Due to the age of the existing facility, multiple items containing hazardous materials were identified throughout the building. Included were asbestos, lead paint, potential sources of poly-chlorinated biphenyl (PCBs), and a 55 gallon drum of HVAC water treatment chemicals. Asbestos was found in pipe fitting insulation, mastic, duct insulation, ceiling tiles, floor tiles, spray-on insulation, and transite asbestos board. Luckily, most of these items were classified as being in fair to good, non-friable condition. Possible PCB containing sources were the old fluorescent light ballasts, power transformers, and hydraulic fluid from the elevator. During demolition and during renovation, the building had containment areas for asbestos abatement. Preventive measures were taken while removing the contaminated materials from the building and also during their disposal. With the exception of some salvageable masonry, little to no recycling of materials was done during the demolition of the original Arena Stage.

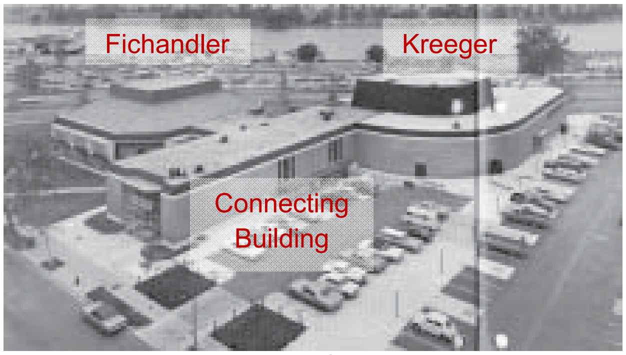


Figure 2: The original Arena Stage built circa 1960/1971

Structural Steel Frame

The structural steel used on Arena Stage is primarily located in the ceiling and the cantilever roof. A series of wide flange girders and beams make up the ceiling system, which carry the loads of the 45' glass façade and transfer them to the PSL timber columns (described in the Curtain Wall section) along the building perimeter. For acoustical reasons, many of the trusses are bearing on isolation pads on steel brackets. This allows for separation of the decks of the composite floor slabs from floor to floor.

Figure 3: Isolation Pad (Cradle)

The cantilever roof is a matrix of diamond oriented bracing trusses and hollow structural section (HSS) beams. HSS beams make up the overhang of the roof that is supported by stainless steel tension cables. Scalloped cladding covers the overhang and gives the building a sleek finish. Due to the intense structural system of the roof, a finalized steel schedule is not yet available.

Two tower cranes are available on Arena Stage's site. The first has a 245' jib length and a 6,600 pound weight capacity. The second tower crane has a 180' jib length and a 6,280 pound weight capacity. They are located in areas of the site where multiple trades can take advantage of their use. One is on the northwest tip of the site and the other is to the southeast of the Fichandler. The use of both cranes makes is possible to reach around the entire site.

Figure 4: The two tower cranes hovering over the Fichandler

Cast-in-Place Concrete

A majority of the new work on Arena Stage utilizes cast-in-place (CIP) concrete. While only a minimal amount is used the Fichandler and the Kreeger, the majority is used on the underground parking garage and the Cradle Theatre. The horizontal pours, along with some vertical work, are being placed using standard formwork with a traditional scaffold frame and stringer/joist assembly.

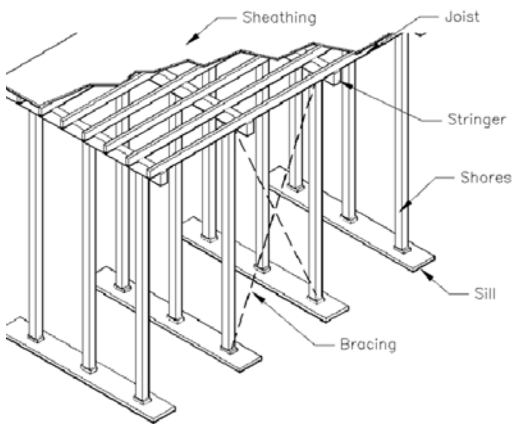


Figure 5: Traditional formwork assembly used for horizontal pours

Due to the nestled, ellipse-shaped walls of the Cradle, the vertical formwork is a much more complex system. To achieve this architectural element, Clark Concrete is using a PERI Formwork System. It consists of a CB 240 climbing platform and RUNDFLEX circular wall formwork. The CB 240 system uses strongbacks which are connected to brackets via a carriage that has a rack and an adjustable brace. 2.40 meter wide pre-fabricated decking is then set level with the brackets and the carriage.

Figure 6: PERI CB 240 climbing platform system (Cradle)

Figure 7: Movement to next lift via crane

The RUNDFLEX circular wall formwork is a flexible solution to the shape and slope of the Cradle walls. There are over 2,000 templates circulating the project in order to successfully place the concrete walls. The templates are placed on the back of the RUNDFLEX formwork, which is then adjusted by either tightening or loosening the joints on the back of it. Once the template is matched, the walls are prepared for pouring in 10' lifts. Since the walls sit on a 4 degree slope, gaps begin to appear in between the runs of formwork. Although it is only about 1" at the bottom of the wall, it is estimated that it will be as large as 17" once the lift is complete. In order to close this gap, custom cut fillers are wedged between the formwork to create a smooth face and consistent horizontal wall joint.

Figure 8: PERI RUNDFLEX formwork prepared for a lift pour

Figure 9: Movement to next lift via crane

This method allows for high bearing capacity, simple moving procedure by crane, ease of retracting large formwork without a crane, and less tripping hazards.

Mechanical System

The HVAC system consists of central boiler and chiller plants and central outdoor air distribution to multiple constant volume air handling systems for the acoustically sensitive spaces and other large spaces. Fan powered induction systems are used for smaller zone control of the back of house areas.

The mechanical classification is a 4-pipe, air-water fan coil system. 4 gas-fired boilers are located in the boiler room located on level 49.5', served by dedicated constant flow primary heating hot water pumps. 2 electric centrifugal chillers are located in the chiller room on level 0.0' of the Fichandler and served by 3 condenser pumps. 2 single cell counterflow centrifugal fan type cooling towers are located on the terrace of level 43.0'.

There are 2, 100% outside air handling units (OHUs). One is located on the roof of the Cradle and the other is in the Kreeger mechanical room. The Kreeger and the Fichandler are each served by 2 separate constant volume air handling units (AHUs), one for the seating area and one for the stage. Due to the smaller size of the black box theatre, the Cradle is only being served by one AHU. 13 other AHUs serve the lobby, mall, switchgear rooms, and other administrative locations. The air handling units, whether constant or variable, range from 3,000 to 43,100 cfm.

Fan powered induction units (FPIUs) provide individual zone temperature control and ventilation to multiple areas in the back of house. Horizontal and vertical fan coil units (FCUs) are provided for unoccupied areas that require cooling/heating. A total of 31 FCUs ranging from 220 to 2,900 cfm are scattered throughout the complex. The primary method for controlling and monitoring the mechanical system is a state of the art control system with stand alone digital controllers.

The fire suppression system implemented in Arena Stage consists of both a wet and dry sprinkler system. It is a combined standpipe and sprinkler system; the sprinkler system is supplied from the standpipe system. Automatic wet-type, Class I standpipe system has an open water supply valve with a maintained pressure. It is capable of supplying water demand is a short amount of time.

<u>Electrical System</u>

Arena Stage's electrical service is supplied by Pepco, a regulated electric utility that provides transmission and distribution services to most of Washington, DC. The main feed is brought into the building and stepped down by a Pepco transformer to a 3Φ, 4 wire, 277/480V, 3000A bus. The size is adjusted throughout the building with 8 Dry Type Transformers. Emergency power is supplied by one 275kW/344kVA separately derived fixed generator system. The generator runs on a 1800 rpm-speed diesel engine that powers 3 emergency multi-duct conduit (EMDC) systems. It was sized to carry the loads of the fire pump, mechanical system, snow melting, lighting, and uninterrupted power supply.

<u>Masonry</u>

Since both the Fichandler and the Kreeger were originally constructed with concrete masonry units (CMUs), cast-in-place concrete, and brick veneer, the same wall type is being matched for the renovation. The brick veneer will be used to restore the exterior faces of the 2 existing theatres and the back side of the Cradle theatre where it connects to the BOH and the Fichandler.

Scaffolding will be used in areas where large spans of masonry are being laid to high elevations. Reinforcing steel and grout is used on load bearing walls and brick veneer is connected to the structure using corrugated metal ties, wire ties, adjustable anchors to structural members, and partition top anchors. Any masonry that was salvageable during demolition and in adequate condition will be reused.

Curtain Wall

The 45' tall curtain wall is one of the main design features of Arena Stage. The glazing is on an inverted 4 degree slope and the wall is a serpentine comprised of multiple radii. It is sectioned off into 12'×7/8" insulated glass frames which weigh approximately 850 pounds per unit. They are hung from the ceiling by stainless steel cables, supporting the dead load of the glass. Since the glass units are so heavy, the system was designed to be installed from the top down. This was done in order to load the cables that are anticipated to stretch ½" as a result of the weight. The cables are then supported by wide flange beams located in the ceiling above the lobby.

Huge parallel strand lumber (PSL) timber columns, designed by StructureCraft Inc., back up the façade and support the entire system. The ellipse-shaped, solid columns range from 48' to 58' in length and are approximately 30" in diameter. Sitting 3' off of the glass, they are placed 36' on center along the perimeter of the building and run continuous up to the roof. Sprouting off the columns are support arms that support the horizontal muntins which carry the lateral loads of the façade. These pieces are connected by an aluminum plate which is penetrated by the stainless steel support cables. The base of the columns is a cast ductile-iron mount that is bolted to the floor.

Figure 10: Parallel Strand Lumber Columns with support arms and muntins

Figure 11: Cast ductile-iron bases

Figure 12: This detail shows the connection of the support arm and muntins to the aluminum plate with (4) tight-fit pins. Also shown is the intersection of the support cable with the aluminum plate.

Support of Excavation

Since the original structures of the Fichandler and the Kreeger theatres are remaining for renovation, proper support was required during excavation. A temporary earth retention system was installed using underpinning and sheeting and shoring. Materials include WF and HP steel piles, low carbon steel lagging studs, tieback tendons, 3” thick hardwood for lagging, tieback grout, and pile shaft backfill.

The underpinning was performed through installation of drilled or driven cantilevered, braced, and tieback HP solider bearing piles. Approach pits and underpinning pits were dug and then excavated with interpier (beam/wale) lagging between pits to the tieback elevation. The Fichandler has underpinning on the interior of three perimeter walls and the Kreeger has it in areas where support walls were removed. Although the system is primarily temporary, a several underpinning locations were permanent.

Sheeting and shoring was also used. After the piles were laid out, they were driven/drilled. Excavation was done and lagging was installed to one foot below each tie or brace elevation. Once the tiebacks were installed and tested, excavation was continued to the subgrade and if required, braces were installed. Cantilevered sheeting was installed on the Main Avenue side of the Kreeger. Above-ground shoring was installed in necessary locations around the Kreeger as well. Tiedback sheeting is on the interior 6th Street wall of the Fichandler. Additional sheeting surrounds the majority of the site around the new building footprint.

Another necessary excavation support was for an existing 8” water line along 6th Street SW. The system is free draining with no allowance for hydrostatic pressures. Based on the groundwater reports, sump pumps were provided on the parking level as the foundation and underslab drainage systems. It was installed prior to excavation to eliminate all hydrostatic pressures against the sheeting system and to lower and maintain the water table below design subgrade.

Figure 13: Underpinning - interpier beam/wale system (Fichandler)

Figure 14: Above-ground shoring (Kreeger)

C. Project Cost Evaluation

Arena Stage's renovation and expansion is a very intense project that has been in the making for over 8 years. It is an extravagant building that is being funded primarily through public and private donations. For this reason, it has been requested by the owner that the cost information pertaining to the project not be revealed. The total project cost, $125 million, is the only number being released to the public. Therefore, no hard costs of the project were obtainable. For this reason, the actual building construction cost and the major building systems costs will be provided as an estimate at the *end* of this section.

Total Building Size: 200,000 square feet (publicized number)

Total Project Costs (TC): $125,000,000

TC/SF: $625

Parametric Estimate [D4 Cost 2002]:

A D4 Cost estimate was prepared to compare the cost of Arena Stage with historic data from the projects in the software. In order to take as many of Arena Stage's features into account, 5 different projects were selected in D4 and a smart average estimate was calculated using the Averaging Wizard.

Project ID	Project Name	Similarity to Arena Stage
CM060542	Midway Studios Multi-Use Renovation	• Historic/restoration • Office space, gallery, café, 200 seat theater
EU950927	Performing Arts Center	• 1,500-seat auditorium • 250-seat black box theater • Classrooms/community space • Located in a neighborhood
EU970127	Fine & Performing Arts Center	• 2-story aluminum and glass façade • 600-seat theater • 150-seat experimental black box theater • Scenery and costume shops
RC980110	American Music Theatre	• Congested site • Extensive value engineering • Luxurious theater
RS070544	Metropolitan Opera House	• Historic/restoration • Premiere entertainment venue • State of the art amenities

Table 2: The 5 Projects used to complete the D4 Cost estimate

Due to the vast differences in the projects from the database, the estimate was adjusted to the correct date, location, and size of Arena Stage.

D4 Estimate for Arena Stage

Page 1

Arena Stage - Jan 2008 - District of Columbia

Prepared By:		Prepared For:	
	, Fax:		, Fax:
Building Sq. Size:	200000	Site Sq. Size:	99071
Bid Date:	1/1/2007	Building use:	Commercial
No. of floors:	4	Foundation:	CON
No. of buildings:	3	Exterior Walls:	GLA
Project Height:	74	Interior Walls:	CMU
1st Floor Height:		Roof Type:	MET
1st Floor Size:		Floor Type:	CON
		Project Type:	ADD/REN

Division		Percent	Sq. Cost	Amount
00	Procurement and Contracting Require	1.80	3.77	753,586
01	General Requirements	4.24	8.86	1,772,003
02	Existing Conditions	6.77	14.15	2,829,174
03	Concrete	5.09	10.63	2,126,754
04	Masonry	5.56	11.62	2,324,049
05	Metals	7.74	16.18	3,235,812
06	Wood, Plastics, and Composites	2.80	5.85	1,169,120
07	Thermal and Moisture Protection	3.19	6.66	1,332,518
08	Openings	3.75	7.83	1,566,784
09	Finishes	8.03	16.79	3,358,120
10	Specialties	0.44	0.92	184,189
11	Equipment	5.76	12.03	2,406,540
12	Furnishings	2.18	4.56	912,809
14	Conveying Systems	1.10	2.31	461,085
15	Mechanical	13.90	29.06	5,811,639
16	Electrical	9.00	18.83	3,765,006
21	Fire Suppression	1.43	2.99	598,993
22	Plumbing	2.58	5.39	1,078,146
23	HVAC	4.84	10.12	2,024,615
26	Electrical	7.07	14.77	2,954,979
31	Earthwork	2.28	4.76	952,079
33	Utilities	0.46	0.97	193,174
Total Building Costs		100.00	209.06	41,811,172

Figure 15: Arena Stage D4 Cost Estimate

The D4 estimate resulted in the following values (from Figure 15 above):

D4 Total Project Costs: $41,811,172

D4 TC/SF: $209.06/SF

The TC/SF cost is over 300% low when compared to the actual TC/SF. It is obvious that the cost values produced by D4 are not usable as an accurate way to estimate the cost to construct Arena Stage. A discussion of the estimates with their relation to the actual cost of the project will be discussed after the R.S. Means estimate.

Square Foot Estimate [R.S. Means]:

R.S. Means is a well known and reliable source for producing a preliminary assemblies estimate for many different types of structures. Since Arena Stage is a theater containing several different spaces, the project first had to be split up into analyzable areas. This was done so that the underground parking garage and the three theatres inside the complex could be estimated separately.

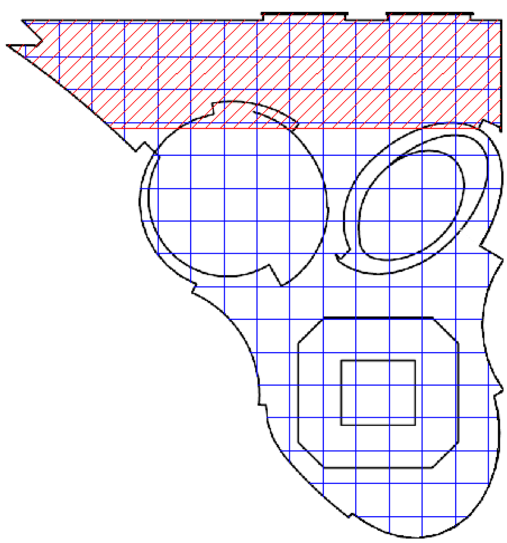


Figure 16: Area break down of Arena Stage for R.S. Means Square Foot Estimate

Figure 16 above shows how the building was broken down into separate areas. The red hatching represents the portion of the building that was assessed as an underground parking garage and the blue hatching is the area that was calculated as an auditorium. The actual square footage of Arena Stage is 200,000 SF with 1 floor below grade and approximately 3 above. It is important to note that all of the values used to perform the R.S. Means estimate are approximate take-offs from an AutoCAD drawing.

Please find the pages used from R.S. Means 2008 Square Foot Costs in the Appendix.

Underground Parking Garage:

The underground parking garage at Arena Stage was estimated in the following manner:

Total Parking Area (SF)	24,365
Building Perimeter (LF)	765
Reinforced Concrete with Reinforced Concrete Frame	
Area (SF)	24,365
Perimeter (LF)	444 (interpolated)
Base SF Cost	$79.30
Perimeter Adjustment (Add) per 100 LF	$4.31 (interpolated)
Adjustable LF	321.55
Add	$13.88
Height Adjustment	N/A (correct height of 10')
Size adjusted SF Cost	$93.18
Location Multiplier for Washington, DC (Commercial)	0.99
Location adjusted SF Cost	$92.25
Common Additive: (1) 3500 lb. capacity (substitute for a freight elevator)	$62,100
Total Building SF Cost	$2,309,772

Table 3: R.S. Means Estimate for an Underground Parking Garage

Theatre, Public, and Administrative Space:

The underground parking garage estimate was then added to the estimate for the theater portion of the complex. This was a much more complicated procedure since there are three separate theater spaces and other administrative and public use spaces all around the building.

Once the parking square footage was determined, it was simple to produce the area of the theatre space:

Theatre Area: 200,000 – 24,365 ≈ 175,650 SF

Since this total area is too big to use with the auditorium estimate and too large to extrapolate, it was then divided by 3 so as to reflect the 3 different theatres and their surrounding spaces.

Approximate Individual Theatre Area: 175,650 ÷ 3 = 58,550 SF

The 3 theatres at Arena Stage were estimated individually in the following manner:

Total Theatre Area (SF)	58,550
Building Perimeter (LF)	800 (estimated)
Face Brick with Concrete Back-up and Steel Frame	
Area (SF)	24,365
Perimeter (LF)	1056 (interpolated)
Base SF Cost	$133.88
Perimeter Adjustment (Deduct) per 100 LF	$1.70 (interpolated)
Adjustable LF	256
Deduct	($4.34)
Adjusted SF Cost	$129.54

Table 4: Beginning of the R.S. Means Estimate for an Auditorium

Although the material chosen for both the exterior wall and framing were not correct, they were the most expensive materials. They were chosen due to the fact that a glass façade was not an option and would definitely have been even more expensive than the chosen materials.

Since the height of all 3 theatres varies, they were then assessed separately:

FICHANDLER – 52' high	
SF Cost from Above	$129.54
Height Adjustment (Add) per 1 ft.	$0.72
Adjustable Height (ft)	28
Add	$20.16
Size adjusted SF Cost	$149.70
Location Multiplier for Washington, DC (Commercial)	0.99
Location adjusted SF Cost	$148.20
Common Additive: (650) seats @ $264 (Veneer backed, padded seat)	$171,600
Total Fichandler SF Cost	$8,848,710

Table 5: Continuation of the R.S. Means Estimate for an Auditorium - Fichandler

KREEGER – 61' high	
SF Cost from Above	$129.54
Height Adjustment (Add) per 1 ft. Adjustable Height (ft)	$0.72 37
Add	$26.64
Size adjusted SF Cost	$156.18
Location Multiplier for Washington, DC (Commercial)	0.99
Location adjusted SF Cost	$154.62
Common Additive: (514) seats @ $264 (Veneer backed, padded seat)	$135,696
Total Fichandler SF Cost	$9,188,697

Table 6: Continuation of the R.S. Means Estimate for an Auditorium - Kreeger

CRADLE – 68' high	
SF Cost from Above	$129.54
Height Adjustment (Add) per 1 ft. Adjustable Height (ft)	$0.72 44
Add	$31.68
Size adjusted SF Cost	$161.22
Location Multiplier for Washington, DC (Commercial)	0.99
Location adjusted SF Cost	$159.61
Common Additive: (200) seats @ $264 (Veneer backed, padded seat)	$52,800
Total Fichandler SF Cost	$9,397,966

Table 7: Continuation of the R.S. Means Estimate for an Auditorium - Cradle

When all of the estimated costs are added together, it results in a total construction cost of $29,745,145.

In order to obtain the Total Building Cost, necessary fees need to be added to the base cost from the square foot estimate:

ARENA STAGE				
Total S.F.				**200,015**
Construction Cost				**$29,745,145.00**
		% of Sub-Total	Cost	Cost/S.F.
Substructure		8.2	$2,439,101.89	$12.19
Shell		35.7	$10,619,016.77	$53.09
	Superstructure	10.3	$3,063,749.94	$15.32
	Exterior Enclosure	20.8	$6,186,990.16	$30.93
	Roofing	4.6	$1,368,276.67	$6.84
Interiors		21.1	$6,276,225.60	$31.38
Services		35.1	$10,440,545.90	$52.20
	Conveying	2.8	$832,864.06	$4.16
	Plumbing	4.6	$1,368,276.67	$6.84
	HVAC	10.2	$3,034,004.79	$15.17
	Fire Protection	2.3	$684,138.34	$3.42
	Electrical	15.2	$4,521,262.04	$22.60
Equipment & Furnishings		0.0	$0.00	$0.00
Special Construction		0.0	$0.00	$0.00
	Sub-Total	100.1	$29,774,890.15	$148.86
Contractor Fees		25	$7,443,722.54	$37.22
Architect Fees		7	$2,084,242.31	$10.42
Total Building Cost			**$39,302,854.99**	**$196.50**

Table 8: R.S. Means Estimate including Fees

As shown in Table 8:

R.S. Means Total Project Costs: $39,302,855

R.S. Means TC/SF: $196.50/SF

It is obvious that the cost values produced by R.S. Means are also not comparable to the actual cost to construct Arena Stage.

Estimate Comparison/Discussion:

Both the D4 Cost and the R.S. Means estimates were more than $80 million under the actual total project cost of $125 million. However, it does not mean that either of these methods is inaccurate. When the D4 and R.S. Means total building costs estimates are compared, they are similar to within 6% of each another:

R.S. Means Total Project Costs: $39,302,855
D4 Total Project Costs: $41,811,172

It is difficult to pin-point where the difference between these methods and the actual cost occurs because there are multiple possible sources of error.

There are many elaborate components to Arena Stage that were not included in the cost estimates due to the fact that there was not the option to take them into consideration. For instance, the serpentine curtain wall with the PSL timber columns is a very distinct and expensive piece of Arena Stage. It would be difficult to find a project with a similar exterior façade in D4 or as an exterior wall option in R.S. Means. The huge cantilever roof is also a major part of the building cost that could not be assessed in these programs. Therefore, they were excluded and were probably a major contribution to the cost difference.

Another important factor is that Arena Stage is undergoing severe demolition and renovation. Although some of the D4 projects that were used for the estimate were also renovations, the extent to which they are being restored is not discussed nor is it quantifiable. R.S. Means is only for new projects being built from the ground up, which Arena Stage also is not.

The shape and size of the complex is also a major source of error. With a curved façade, an ellipse-shaped theatre, and varying roof heights, it is hard to distinguish and properly calculate where one theatre ends and the next begins. The three individual theatres of are also very different with respect to building materials and starting elevation. It would be very difficult to break up Arena Stage into appropriate areas according to their function in order to achieve a more accurate estimate.

Had Arena Stage been a square-shaped building with repeatable floors, these estimates may have been more precise. Unfortunately, it is not. The complexities of the project inhibit using simple estimating methods like D4 or R.S. Means as accurate pricing tools.

Estimate of other Costs:

Using R.S. Means percentages, the unobtainable costs were determined from the actual Total Project Costs as follows:

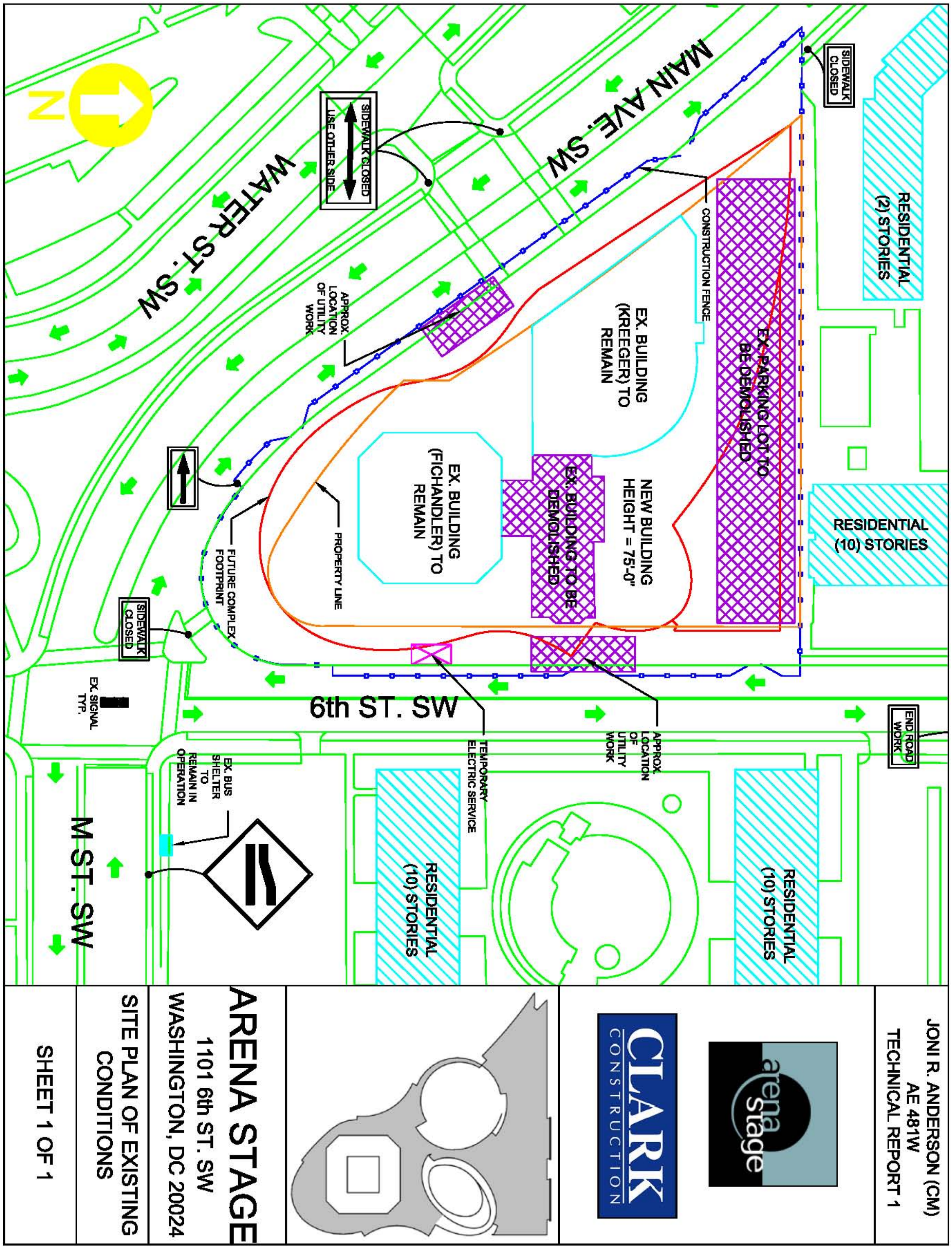
Actual Building Construction Cost (CC): $85,000,000
CC/SF: $425

Major Building Systems Costs:

	Cost	Cost/SF
Mechanical System	$8,670,000	$43.35
Plumbing System	$3,910,000	$19.55
Fire Protection	$1,955,000	$9.78
Electrical System	$12,920,000	$64.60
Structural System	$37,315,000	$186.58

Table 9: Estimated Major Building Systems Costs

D. Site Plan of Existing Conditions



E. Local Conditions

Arena Stage is located on the corner of Sixth Street and Main Avenue in Southwest Washington, DC. Main Avenue SW is a busy street that runs the length of the Washington Channel and terminates at the Tidal Basin with the intersection of 17th Street and Independence Ave. The site has an awkward triangular shape and is adjacent to several residential high-rises to the north and east.

Figure 17: Map of the National Mall and Arena Stage (enlarged aerial view of the existing building)

In Washington, DC, there are certain preferred methods of construction. Due to the Heights of Buildings Act of 1899, building heights are not to exceed that of the United States Capitol building, which rises to 288 feet tall. Although there are a several steel framed buildings scattered throughout the city, the majority of the buildings are reinforced concrete. Building with concrete allows smaller floor-to-floor heights and, in an area where building height is restricted, this means that a greater number of floors can be constructed within a given height. Concrete is versatile, durable, cost effective, has high compressive strength, and cuts out the lead time that steel requires. Although Arena Stage is not building for height, the majority of the structure for the new work is cast-in-place concrete.

An unfortunate aspect of the project location is that the site is very congested and designating parking areas onsite was not an option. Therefore, the field personnel are responsible for finding and paying for their own parking. This does not include the Project Executive and the Construction Executive, who both have their parking located and paid for them. Anyone who has visited downtown DC knows that finding cheap and convenient parking can be a bit of a challenge. As shown in Figure 18 below, a lot of the parking around Arena Stage is limited to on-street parking. Notice that 6th Street is reserved as residential permit parking (RPP) for the surrounding apartment complexes and Main Avenue and Water Street only have variable rate meters. This means that many members of the project team may spend a long time trying to find parking in the morning and it may not even be close to the site. Also, they must monitor the meters throughout the day to make sure that they do not run out of parking time.

Figure 18: A map of parking regulations provided by the D.C. Department of Transportation

Clark Construction, with the exception of recycling paper within the field offices, has performed little to no recycling on the project. This is mostly due to the congested nature of the site and the limited amount of recyclable materials. The company has its own dumpster and waste removal service, so tipping fees and recycling costs are not available for comparison to the average costs of the service.

Based on a geotechnical report prepared by ATC Associates, Inc., the natural subsoils on the site are Coastal Plain Lowland Deposits. 12 soil test borings were performed and the subsurface soil conditions of the site have been generalized into 3 strata types. The first, stratum A, is located closest to the existing surface under about 4 to 6 inches of topsoil. It consists of light brown, moist silty to gravely sand to very fine silty clay with possible fill materials. Although most of this material had a relatively dense consistency, 2 borings reflected loose material near finish floor elevations. The second, stratum B, was wet, light grayish-brown, very soft silty clay to loose silty or gravely sand and was located 26 to 48.5 feet from the surface. The last, stratum C, at depths of 36.5 to 55 feet, was very moist and dark. It consists of medium to extremely dense silty sand.

The subsurface water conditions were determined from groundwater readings. Level measurements were taken in each of the borings after drilling. Also, two monitoring wells, extending to 55 feet below the surface, were installed and obtained measurements for approximately 4 weeks. From this, scientist predicted that the long-term static water level for the project is expected to remain at an elevation of -5 feet, mean sea level (msl). Since the finish floor elevation is approximately 9 feet, msl, a wellpoint dewatering system was not suggested, but precautions are suggested for perched or trapped water. Sump pumps were the result.

F. Client Information

Washington Drama Society, Inc. DBA Arena Stage, is a not-for-profit organization and is the largest producing theater in North America that focuses on American plays. For the last sixty years, Arena Stage has entertained over 200,000 patrons and considered a very important community attraction. Despite the fact that it is not old enough to be considered a historic landmark, Arena Stage's cultural significance and positive impact on the public earned it a spot in the District of Columbia Inventory of Historic Sites.

In 1999, Arena Stage decided to build a new facility and, instead of relocating to a new site, the Board of Trustees chose to remain in their waterfront location. The rebirth of Arena Stage, called The Next Stage Campaign, involves a massive renovation of the Fichandler and Kreeger theatres complete with modern amenities, updated décor, enhanced acoustics, and brand new building equipment. Also, an additional space called the Cradle is being added to promote the writing and production of new American plays. For the public, the complex will not only provide opportunity for a diverse workforce, but plans for community outreach and educational programs are in order.

When the decision was made to construct a new facility, the opportunity to move Arena Stage to a high-end, downtown location was tempting. However, by staying in the original location, The Next Stage became a part of the city's Anacostia Waterfront Initiative (AWI) (www.AnacostiaWaterfront.net). The goal of the initiative is to make the Southwest DC Waterfront a more alluring section of the city and join the ranks as a leading attraction. It is currently the city's number one economic development priority. The new Arena Stage is a crucial part of the city's revitalization, just like the New Nationals Ballpark which was one of the first major movements. The city hopes that these new public landmarks will have a contagious effect on other markets and encourage them to join the AWI.

Arena Stage did not publicly announce that it was building a new complex for many years due to a lack of funding. However, two Life Trustees, named Gilbert and Jaylee Mead, made the vision possible. As long time supporters of the performing arts in DC, the couple donated over $100 million toward the Campaign. The couple's unyielding support is expressible through their service on the Arena Stage Board of Trustees, sponsorship of productions, community service, and philanthropy toward multiple theatres in the Washington region. Sadly, Gilbert Mead passed away in May of 2007. In recognition of the Mead's commitment and generosity, the new theatre complex will be named "The Mead Center for American Theater" in their honor.

In December of 2007, Arena Stage moved to a new location in Crystal City, VA to allow for the 2-year construction process. Since performing arts facilities operate in terms of seasons, the project schedule is very important to the owner. Arena Stage needs the project to be completed on time so that they can move back to the new theatre and have the grand opening for the 2010-2011 season. Since the project's funding is coming from donations, a major fundraising feasibility study was performed to make sure that the architect's design for the building was achievable. As it usually is, cost is a crucial factor to Arena Stage. Multiple design changes were made through value engineering so that the project is delivered within the budget. Although the cost of the project has fluctuated throughout the last 8 years, there has been no compromise of the project's quality. As stated before, the new complex is going to be a very modern, high-end facility that will serve as a role model for other movements of the Anacostia Waterfront Initiative.

G. Project Delivery System

Arena Stage is being delivered as a modified bid and project proposal process. Due to the complexity and uniqueness of the project, Arena Stage chose not to use the traditional bid process.

The owner presented the proposed building to 5 different contractors who they hand-picked with the help of the project manager. All of the selected contractors had experience in building either stadiums or theaters and therefore seemed like qualified candidates. When 2 contractors responded with interest in the project, Arena Stage requested that each company submit a detailed proposal.

Each group submitting a proposal had to provide a 2 hour presentation detailing how they would construct the project. This consisted of scheduling, construction procedure, staffing, and material procurement. It also consisted of a Question and Answer sequence concerning the sub-contractor bid and buyout process.

Since the contract is a Guaranteed Maximum Price based on an open book buyout with the owner involved, the only competitive comparison was that of the proposed fee and also a quantitative look at the General Conditions between the submitting GC's. It was also important for the candidates to have a firm grasp on the complex requirements of the project. In May 2007, Clark Construction Group, LLC was awarded the construction contract for Arena Stage.

The owner would not disclose the types of contracts held between their consultants, nor would Clark describe their bonding and insurance requirements in detail. However, all of the subcontractors working for Clark were selected through competitive bid and all of the contracts are lump sum. Insurance is generally required for all subcontractors. The size of the contracts determines the bonding requirements. For the larger contracts, like those for the major building systems shown in Figure 19, bonds are required.

The delivery system for Arena Stage was tailored to fit the requirements of the project, therefore it is an appropriate approach. There are many complexities that go into the construction of the building and they may not have been recognized by the construction companies had it been a competitive bid. The fact that the contractors got to work closely with the Arena Stage and KCI during the bidding process assured them that all facets of the project were being considered and, therefore, satisfactory results could be produced.

Organizational Chart:

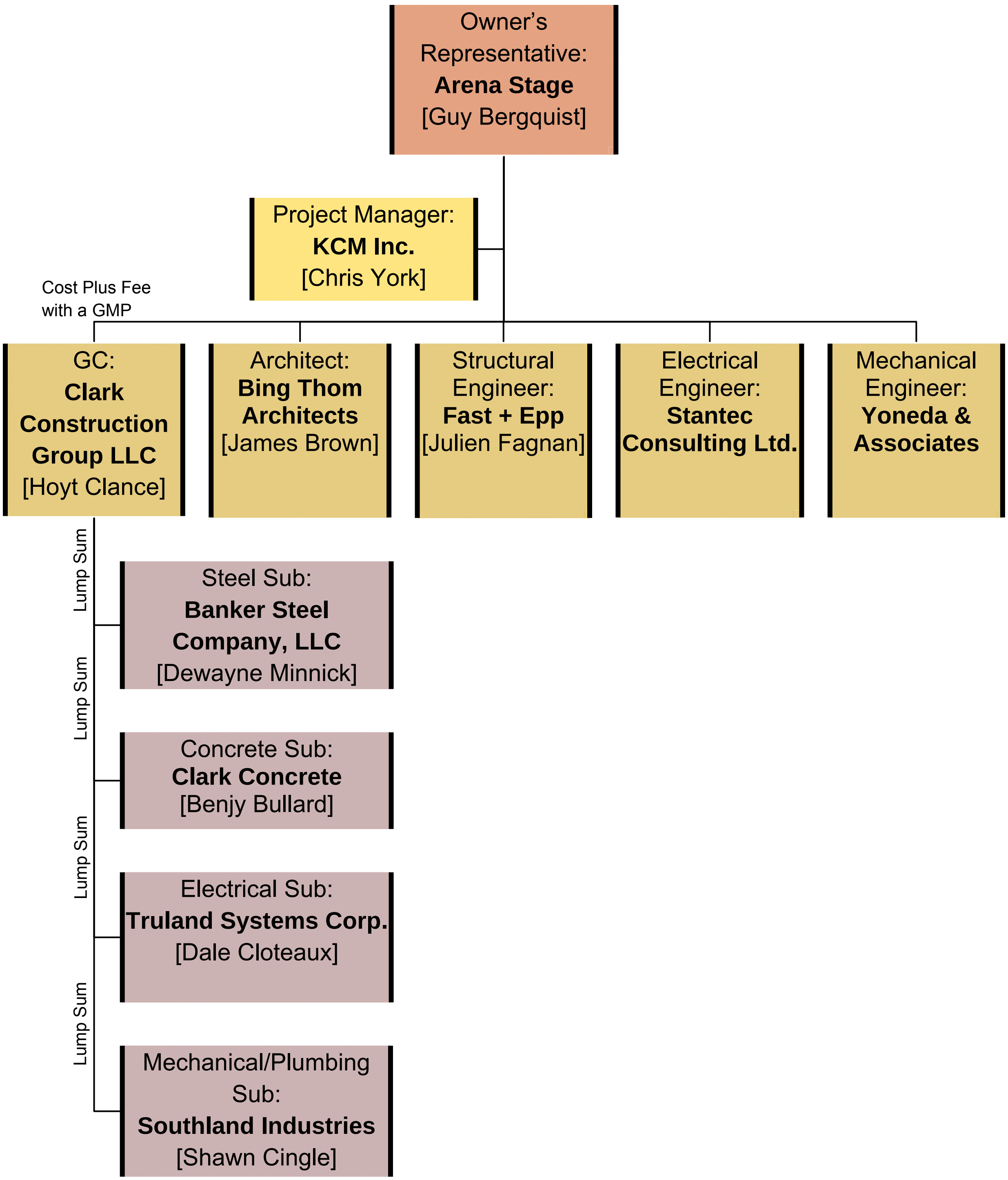


Figure 19: Arena Stage Organizational Chart

H. Staffing Plan

The General Contractor, Clark Construction, is broken up into two management categories to facilitate the complex supervision required for Arena Stage.

Project Management:

The first side of the operation is Project Management. This group of individuals is responsible for the office-related procedures. Project Executive, George Conrad, oversees the general operations of the job, specifically the budget. While PE's are generally only onsite an average of two to three days a week, George is present mostly 5 days a week. The Project Manager, Matt Galbraith, works closely with both George Conrad and with the Construction Executive. He is concerned with both the budget and schedule related issues. Matt also delegates responsibilities to his subordinates and supervises them daily. Akeem Etheridge is the project's Safety Manager. He is responsible for observing the overall activities being performed throughout the site. His main purpose is to help create a safe environment by preventing dangerous practices. Akeem is accountable for being aware of proper procedures and safe construction methods. Since he is the Safety Manager on multiple projects, Akeem is only on site for half of the day. Michelle Choe, the Project Engineer, is an assistant to Matt. She makes sure that the procedures in the office are implemented in the field. The MEP Coordinator, Charlie Luskey, is another assistant to the PM. Mr. Luskey directly manages the MEP subcontractors during preparation of the shop drawings and actual installation of the building systems. He makes sure that the subs are properly coordinating their work with one another to avoid field busts and other MEP related issues. The four Office Engineers are responsible for managing specific trades. Each is accountable for several subcontractors with whom they communicate and make sure all necessary paperwork is completed and successfully submitted.

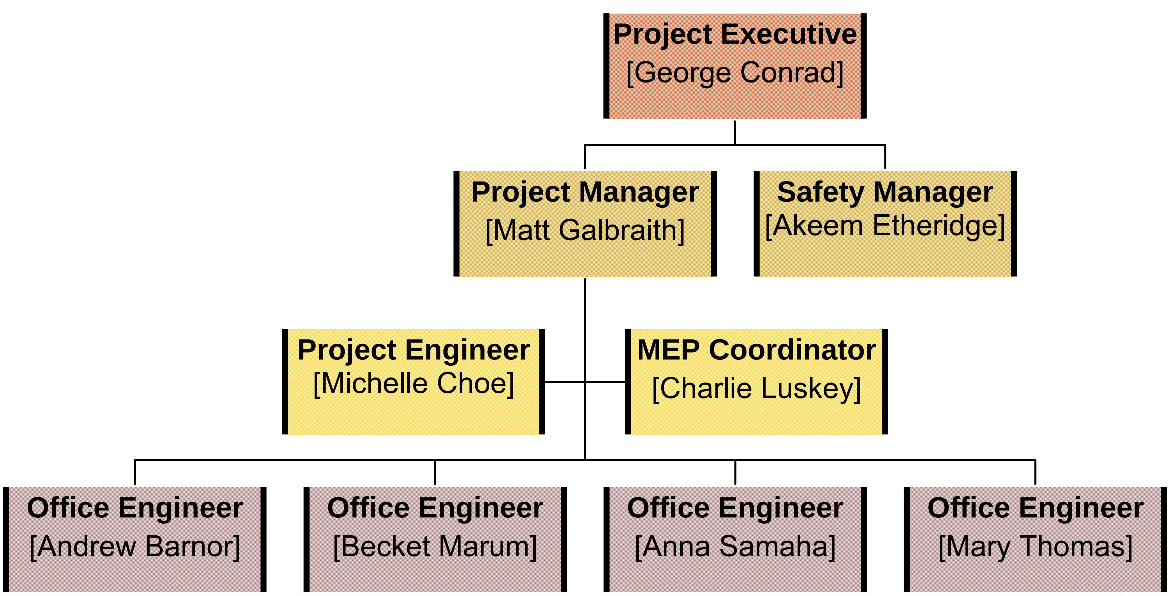


Figure 20: Project Management Staffing Chart

Field Supervision:

The second side of Clark's management is the Field Supervision. Joe Swank, the Construction Executive, oversees all field operations and resolves issues on the project that are above the authority of his subordinates. He is also responsible for managing the schedule and making sure that the project is delivered on time. Joe is onsite every day that field operations are being conducted. The General Superintendent is Hoyt Clance. Although he supervises everything from demolition to renovation, Hoyt is the primary overseer of the new work on the Cradle. Two Assistant Superintendents work alongside Hoyt and they are each responsible for supervising an individual area. In the case of Arena Stage, the areas consist of the Fichandler, the Kreeger, and the Cradle. Three Field Engineers serve as assistants to the Superintendents. Daily tasks include laying out in the field and working alongside members of the craft to ensure the proper completion of individual activities.

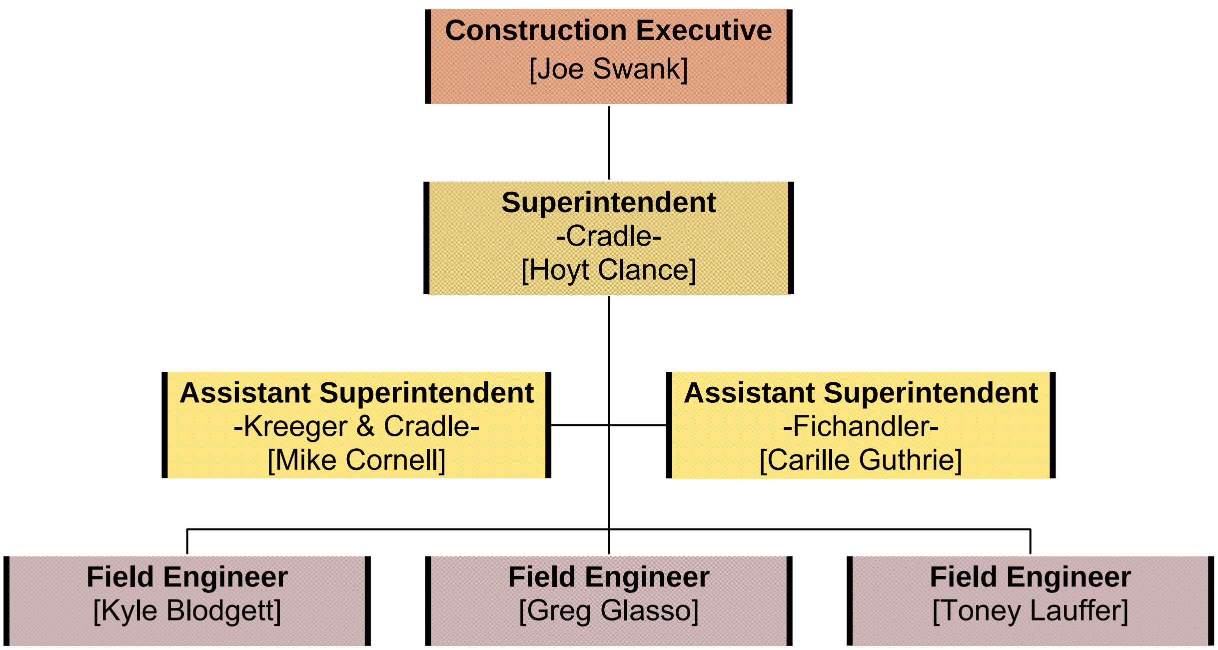
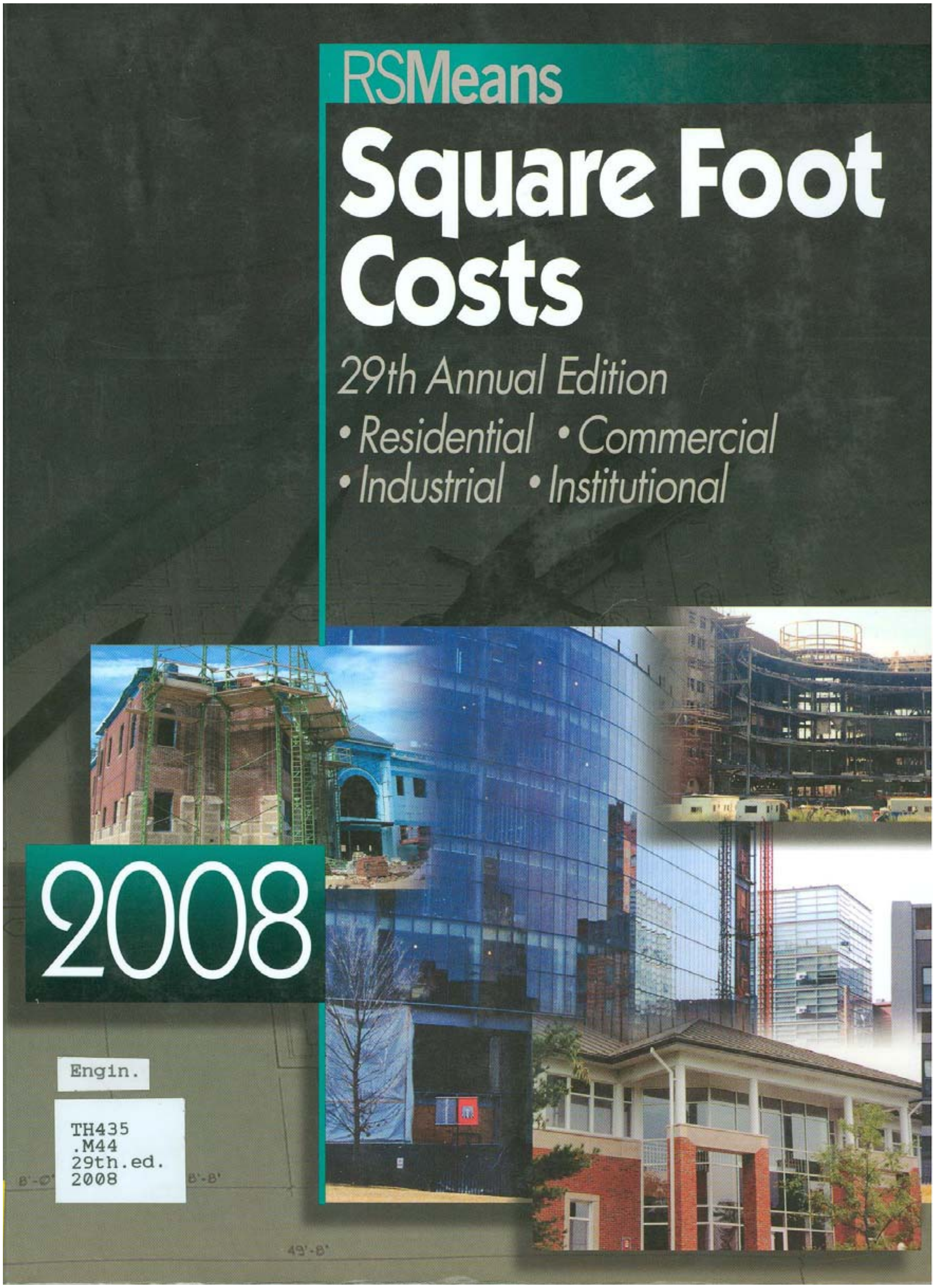


Figure 21: Field Supervision Staffing Chart

Appendix (R.S. Means 2008 Square Foot Costs):



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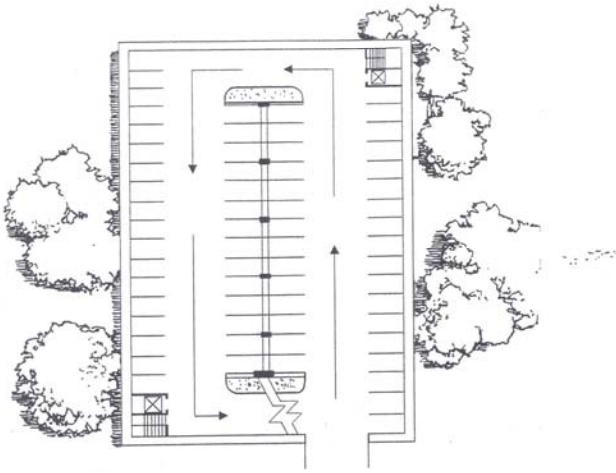

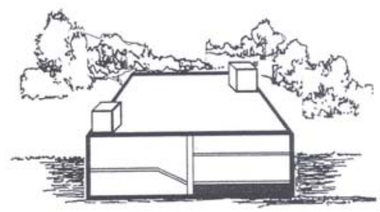

Costs per square foot of floor area

Exterior Wall	S.F. Area	20000	30000	40000	50000	75000	100000	125000	150000	175000
	L.F. Perimeter	400	500	600	650	775	900	1000	1100	1185
Reinforced Concrete	R/Conc. Frame	81.90	75.95	73.00	70.15	66.45	64.65	63.30	62.35	61.70
Perimeter Adj., Add or Deduct	Per 100 L.F.	5.05	3.35	2.45	2.05	1.35	0.95	0.75	0.70	0.55
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	1.95	1.60	1.45	1.25	1.00	0.80	0.70	0.70	0.65
Basement—Not Applicable										

The above costs were calculated using the basic specifications shown on the facing page. These costs should be adjusted where necessary for design alternatives and owner's requirements. Reported completed project costs, for this type of structure, range from $ 42.85 to $ 102.15 per S.F.

Common additives

Description	Unit	$ Cost
Elevators, Hydraulic passenger, 2 stops		
1500# capacity	Each	55,100
2500# capacity	Each	57,800
3500# capacity	Each	62,100
Barrier gate w/programmable controller	Each	3950
Booth for attendant, average	Each	12,300
Fee computer	Each	14,900
Ticket spitter with time/date stamp	Each	7450
Mag strip encoding	Each	20,900
Collection station, pay on foot	Each	126,000
Parking control software	Each	25,200 - 103,000
Painting, Parking stalls	Stall	9.75
Parking Barriers		
Timber with saddles, 4" x 4"	L.F.	6.70
Precast concrete, 6" x 10" x 6'	Each	69.50
Traffic Signs, directional, 12" x 18"	Each	79.50

Important: See the Reference Section for Location Factors

Model costs calculated for a 2 story building with 10′ story height and 100,000 square feet of floor area

Garage, Underground Parking

			Unit	Unit Cost	Cost Per S.F.	% Of Sub-Total
A. SUBSTRUCTURE						
1010	Standard Foundations	Poured concrete; strip and spread footings and waterproofing	S.F. Ground	7.04	3.52	22.4%
1020	Special Foundations	N/A	—	—	—	
1030	Slab on Grade	5″ reinforced concrete with vapor barrier and granular base	S.F. Slab	6.13	3.07	
2010	Basement Excavation	Excavation 24′ deep	S.F. Ground	8.30	4.15	
2020	Basement Walls	N/A	—	—	—	
B. SHELL						
	B10 Superstructure					
1010	Floor Construction	Cast-in-place concrete beam and slab, concrete columns	S.F. Floor	25.04	12.52	50.4%
1020	Roof Construction	Cast-in-place concrete beam and slab, concrete columns	S.F. Roof	23.22	11.61	
	B20 Exterior Enclosure					
2010	Exterior Walls	Cast-in place concrete	S.F. Wall	19.67	3.54	7.7%
2020	Exterior Windows	N/A	—	—	—	
2030	Exterior Doors	Steel overhead, hollow metal	Each	3784	.16	
	B30 Roofing					
3010	Roof Coverings	Neoprene membrane traffic deck	S.F. Roof	3.98	1.99	4.2%
3020	Roof Openings	N/A	—	—	—	
C. INTERIORS						
1010	Partitions	Concrete block	S.F. Partition	36.40	.70	2.4%
1020	Interior Doors	Hollow metal	Each	6736	.06	
1030	Fittings	N/A	—	—	—	
2010	Stair Construction	Concrete	Flight	5725	.28	
3010	Wall Finishes	Paint	S.F. Surface	2.34	.09	
3020	Floor Finishes	N/A	—	—	—	
3030	Ceiling Finishes	N/A	—	—	—	
D. SERVICES						
	D10 Conveying					
1010	Elevators & Lifts	Two hydraulic passenger elevators	Each	68,500	1.37	2.9%
1020	Escalators & Moving Walks	N/A	—	—	—	
	D20 Plumbing					
2010	Plumbing Fixtures	Drainage in parking areas, toilets, & service fixtures *1 Fixture/5000 S.F. Floor*	Each	.31	.31	2.9%
2020	Domestic Water Distribution	Electric water heater	S.F. Floor	.10	.10	
2040	Rain Water Drainage	Roof drains	S.F. Roof	1.96	.98	
	D30 HVAC					
3010	Energy Supply	N/A	—	—	—	0.3 %
3020	Heat Generating Systems	N/A	—	—	—	
3030	Cooling Generating Systems	N/A	—	—	—	
3050	Terminal & Package Units	Exhaust fans	S.F. Floor	.12	.12	
3090	Other HVAC Sys. & Equipment	N/A	—	—	—	
	D40 Fire Protection					
4010	Sprinklers	N/A	—	—	—	0.3 %
4020	Standpipes	Dry standpipe system, class 1	S.F. Floor	.13	.13	
	D50 Electrical					
5010	Electrical Service/Distribution	200 ampere service, panel board and feeders	S.F. Floor	.12	.12	5.9%
5020	Lighting & Branch Wiring	Fluorescent fixtures, receptacles, switches and misc. power	S.F. Floor	2.27	2.27	
5030	Communications & Security	Alarm systems and emergency lighting	S.F. Floor	.38	.38	
5090	Other Electrical Systems	Emergency generator, 11.5 kW	S.F. Floor	.06	.06	
E. EQUIPMENT & FURNISHINGS						
1010	Commercial Equipment	N/A	—	—	—	0.7 %
1020	Institutional Equipment	N/A	—	—	—	
1030	Vehicular Equipment	Ticket dispensers, booths, automatic gates	S.F. Floor	.35	.35	
1090	Other Equipment	N/A	—	—	—	
F. SPECIAL CONSTRUCTION						
1020	Integrated Construction	N/A	—	—	—	0.0 %
1040	Special Facilities	N/A	—	—	—	
G. BUILDING SITEWORK		**N/A**				
				Sub-Total	47.88	**100%**
	CONTRACTOR FEES (General Requirements: 10%, Overhead: 5%, Profit: 10%)			*25%*	11.98	
	ARCHITECT FEES			*8%*	4.79	
				Total Building Cost	**64.65**	

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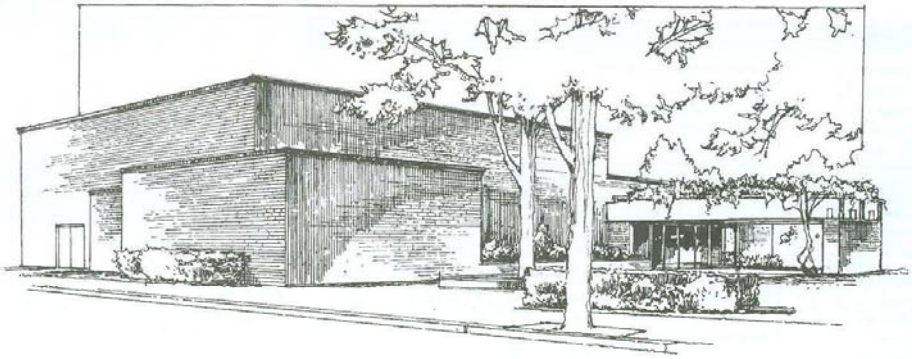
COMMERCIAL/INDUSTRIAL/ INSTITUTIONAL | M.040 | Auditorium



Costs per square foot of floor area

Exterior Wall	S.F. Area	12000	15000	18000	21000	24000	27000	30000	33000	36000
	L.F. Perimeter	440	500	540	590	640	665	700	732	770
Face Brick with Concrete Block Back-up	Steel Frame	166.60	161.35	156.20	153.15	150.90	147.80	145.85	144.10	142.90
	Bearing Wall	160.75	155.95	151.35	148.60	146.60	143.90	142.10	140.55	139.45
Precast Concrete	Steel Frame	164.70	159.60	154.70	151.80	149.65	146.70	144.85	143.15	142.00
Decorative Concrete Block	Bearing Wall	144.05	140.70	137.60	135.65	134.30	132.45	131.20	130.15	129.40
Concrete Block	Steel Frame	151.55	148.85	146.45	144.95	143.85	142.45	141.50	140.65	140.10
	Bearing Wall	139.55	136.65	133.90	132.20	131.00	129.35	128.35	127.45	126.75
Perimeter Adj., Add or Deduct	Per 100 L.F.	11.85	9.45	7.85	6.75	5.95	5.35	4.75	4.25	3.95
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	1.90	1.70	1.50	1.40	1.35	1.30	1.15	1.15	1.10

For Basement, add $ 24.90 per square foot of basement area

The above costs were calculated using the basic specifications shown on the facing page. These costs should be adjusted where necessary for design alternatives and owner's requirements. Reported completed project costs, for this type of structure, range from $76.90 to $ 194.70 per S.F.

Common additives

Description	Unit	$ Cost
Closed Circuit Surveillance, One station		
Camera and monitor	Each	1750
For additional camera stations, add	Each	940
Emergency Lighting, 25 watt, battery operated		
Lead battery	Each	278
Nickel cadmium	Each	800
Seating		
Auditorium chair, all veneer	Each	218
Veneer back, padded seat	Each	264
Upholstered, spring seat	Each	264
Classroom, movable chair & desk	Set	65 - 120
Lecture hall, pedestal type	Each	208 - 620
Smoke Detectors		
Ceiling type	Each	174
Duct type	Each	445
Sound System		
Amplifier, 250 watts	Each	2225
Speaker, ceiling or wall	Each	181
Trumpet	Each	345

Important: See the Reference Section for Location Factors

Model costs calculated for a 1 story building with 24' story height and 24,000 square feet of floor area

Auditorium

			Unit	Unit Cost	Cost Per S.F.	% Of Sub-Total
A. SUBSTRUCTURE						
1010	Standard Foundations	Poured concrete; strip and spread footings	S.F. Ground	1.29	1.29	8.2%
1020	Special Foundations	N/A	—	—	—	
1030	Slab on Grade	6" reinforced concrete with vapor barrier and granular base	S.F. Slab	5.60	5.60	
2010	Basement Excavation	Site preparation for slab and trench for foundation wall and footing	S.F. Ground	.15	.15	
2020	Basement Walls	4' foundation wall	L.F. Wall	78	2.08	
B. SHELL						
B10 Superstructure						
1010	Floor Construction	Open web steel joists, slab form, concrete *(balcony)*	S.F. Floor	21.76	2.72	10.3%
1020	Roof Construction	Metal deck on steel truss	S.F. Roof	8.75	8.75	
B20 Exterior Enclosure						
2010	Exterior Walls	Precast concrete panel *80% of wall (adjusted for end walls)*	S.F. Wall	33.20	17	20.8%
2020	Exterior Windows	Glass curtain wall *20% of wall*	Each	35.60	4.56	
2030	Exterior Doors	Double aluminum and glass and hollow metal	Each	3373	1.68	
B30 Roofing						
3010	Roof Coverings	Built-up tar and gravel with flashing; perlite/EPS composite insulation	S.F. Roof	4.97	4.97	4.6%
3020	Roof Openings	Roof hatches	S.F. Roof	.16	.16	
C. INTERIORS						
1010	Partitions	Concrete Block and toilet partitions *40 S.F. Floor/L.F. Partition*	S.F. Partition	8.05	3.22	21.1%
1020	Interior Doors	Single leaf hollow metal *400 S.F. Floor/Door*	Each	842	2.11	
1030	Fittings	Toilet partitions	S.F. Floor	—	—	
2010	Stair Construction	Concrete filled metal pan	Flight	14,500	1.82	
3010	Wall Finishes	70% paint, 30% epoxy coating	S.F. Surface	4.73	3.78	
3020	Floor Finishes	70% vinyl tile, 30% carpet	S.F. Floor	9.14	9.14	
3030	Ceiling Finishes	Fiberglass board, suspended	S.F. Ceiling	3.53	3.53	
D. SERVICES						
D10 Conveying						
1010	Elevators & Lifts	One hydraulic passenger elevator	Each	75,360	3.14	2.8%
1020	Escalators & Moving Walks	N/A	—	—	—	
D20 Plumbing						
2010	Plumbing Fixtures	Toilet and service fixtures, supply and drainage *1 Fixture/800 S.F. Floor*	Each	3216	4.02	4.6%
2020	Domestic Water Distribution	Gas fired water heater	S.F. Floor	.32	.32	
2040	Rain Water Drainage	Roof drains	S.F. Roof	.82	.82	
D30 HVAC						
3010	Energy Supply	N/A	—	—	—	10.2 %
3020	Heat Generating Systems	Included in D3050	—	—	—	
3030	Cooling Generating Systems	N/A	—	—	—	
3050	Terminal & Package Units	Single zone rooftop unit, gas heating, electric cooling	S.F. Floor	11.45	11.45	
3090	Other HVAC Sys. & Equipment	N/A	—	—	—	
D40 Fire Protection						
4010	Sprinklers	Wet pipe sprinkler system	S.F. Floor	2.62	2.62	2.3%
4020	Standpipes	N/A	—	—	—	
D50 Electrical						
5010	Electrical Service/Distribution	800 ampere service, panel board and feeders	S.F. Floor	2.24	2.24	15.2%
5020	Lighting & Branch Wiring	Fluorescent fixtures, receptacles, switches, A.C. and misc. power	S.F. Floor	10.55	10.55	
5030	Communications & Security	Alarm systems and emergency lighting, and public address system	S.F. Floor	2.97	2.97	
5090	Other Electrical Systems	Emergency generator, 100KW	S.F. Floor	1.20	1.20	
E. EQUIPMENT & FURNISHINGS						
1010	Commercial Equipment	N/A	—	—	—	0.0 %
1020	Institutional Equipment	N/A	—	—	—	
1030	Vehicular Equipment	N/A	—	—	—	
1090	Other Equipment	N/A	—	—	—	
F. SPECIAL CONSTRUCTION						
1020	Integrated Construction	N/A	—	—	—	0.0 %
1040	Special Facilities	N/A	—	—	—	
G. BUILDING SITEWORK		N/A				
			Sub-Total		111.89	**100%**
	CONTRACTOR FEES (General Requirements: 10%, Overhead: 5%, Profit: 10%)			25%	27.97	
	ARCHITECT FEES			7%	9.79	
			Total Building Cost		**149.65**	

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Location Factors

Costs shown in *RSMeans Square Foot Costs* are based on National Averages for materials and installation. To adjust these costs to a specific location, simply multiply the base cost by the factor for that city. The data is arranged alphabetically by state and postal zip code numbers. For a city not listed, use the factor for a nearby city with similar economic characteristics.

STATE/ZIP	CITY	Residential	Commercial
ALABAMA			
350-352	Birmingham	.88	.88
354	Tuscaloosa	.79	.81
355	Jasper	.73	.79
356	Decatur	.79	.81
357-358	Huntsville	.85	.86
359	Gadsden	.76	.81
360-361	Montgomery	.78	.81
362	Anniston	.74	.78
363	Dothan	.77	.78
364	Evergreen	.75	.80
365-366	Mobile	.83	.84
367	Selma	.75	.79
368	Phenix City	.76	.81
369	Butler	.76	.79
ALASKA			
995-996	Anchorage	1.27	1.24
997	Fairbanks	1.29	1.24
998	Juneau	1.26	1.22
999	Ketchikan	1.30	1.29
ARIZONA			
850,853	Phoenix	.86	.89
852	Mesa/Tempe	.83	.86
855	Globe	.79	.85
856-857	Tucson	.85	.87
859	Show Low	.81	.86
860	Flagstaff	.86	.89
863	Prescott	.80	.84
864	Kingman	.83	.86
865	Chambers	.80	.84
ARKANSAS			
716	Pine Bluff	.81	.84
717	Camden	.69	.73
718	Texarkana	.74	.76
719	Hot Springs	.69	.74
720-722	Little Rock	.85	.85
723	West Memphis	.79	.81
724	Jonesboro	.78	.82
725	Batesville	.75	.77
726	Harrison	.76	.79
727	Fayetteville	.71	.77
728	Russellville	.76	.78
729	Fort Smith	.78	.81
CALIFORNIA			
900-902	Los Angeles	1.08	1.08
903-905	Inglewood	1.04	1.04
906-908	Long Beach	1.03	1.05
910-912	Pasadena	1.04	1.04
913-916	Van Nuys	1.07	1.06
917-918	Alhambra	1.08	1.05
919-921	San Diego	1.06	1.05
922	Palm Springs	1.04	1.04
923-924	San Bernardino	1.04	1.02
925	Riverside	1.08	1.07
926-927	Santa Ana	1.05	1.04
928	Anaheim	1.08	1.07
930	Oxnard	1.09	1.07
931	Santa Barbara	1.08	1.07
932-933	Bakersfield	1.06	1.06
934	San Luis Obispo	1.07	1.05
935	Mojave	1.05	1.03
936-938	Fresno	1.09	1.08
939	Salinas	1.10	1.09
940-941	San Francisco	1.25	1.23
942,956-958	Sacramento	1.11	1.09
943	Palo Alto	1.18	1.14
944	San Mateo	1.23	1.17
945	Vallejo	1.16	1.13
946	Oakland	1.22	1.18
947	Berkeley	1.24	1.16
948	Richmond	1.25	1.16
949	San Rafael	1.23	1.17
950	Santa Cruz	1.14	1.12
951	San Jose	1.21	1.17
952	Stockton	1.08	1.08
953	Modesto	1.08	1.07

STATE/ZIP	CITY	Residential	Commercial
CALIFORNIA (CONT'D)			
954	Santa Rosa	1.17	1.14
955	Eureka	1.11	1.07
959	Marysville	1.09	1.07
960	Redding	1.09	1.08
961	Susanville	1.09	1.07
COLORADO			
800-802	Denver	.93	.94
803	Boulder	.93	.92
804	Golden	.91	.93
805	Fort Collins	.89	.92
806	Greeley	.79	.86
807	Fort Morgan	.92	.92
808-809	Colorado Springs	.90	.93
810	Pueblo	.91	.93
811	Alamosa	.88	.92
812	Salida	.90	.92
813	Durango	.91	.92
814	Montrose	.87	.91
815	Grand Junction	.91	.92
816	Glenwood Springs	.90	.93
CONNECTICUT			
060	New Britain	1.11	1.09
061	Hartford	1.11	1.09
062	Willimantic	1.11	1.09
063	New London	1.10	1.07
064	Meriden	1.11	1.08
065	New Haven	1.11	1.10
066	Bridgeport	1.12	1.10
067	Waterbury	1.11	1.09
068	Norwalk	1.11	1.09
069	Stamford	1.12	1.11
D.C.			
200-205	Washington	.96	.99
DELAWARE			
197	Newark	1.04	1.04
198	Wilmington	1.05	1.04
199	Dover	1.03	1.05
FLORIDA			
320,322	Jacksonville	.82	.84
321	Daytona Beach	.90	.89
323	Tallahassee	.78	.79
324	Panama City	.75	.78
325	Pensacola	.82	.85
326,344	Gainesville	.81	.86
327-328,347	Orlando	.90	.89
329	Melbourne	.91	.92
330-332,340	Miami	.87	.89
333	Fort Lauderdale	.85	.88
334,349	West Palm Beach	.85	.85
335-336,346	Tampa	.92	.91
337	St. Petersburg	.79	.83
338	Lakeland	.89	.91
339,341	Fort Myers	.87	.87
342	Sarasota	.90	.88
GEORGIA			
300-303,399	Atlanta	.89	.90
304	Statesboro	.71	.77
305	Gainesville	.79	.83
306	Athens	.79	.84
307	Dalton	.75	.79
308-309	Augusta	.80	.83
310-312	Macon	.81	.83
313-314	Savannah	.82	.82
315	Waycross	.75	.80
316	Valdosta	.73	.77
317,398	Albany	.78	.82
318-319	Columbus	.83	.84
HAWAII			
967	Hilo	1.22	1.19
968	Honolulu	1.25	1.21

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