Technical Report #1

Construction Project Management

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Contents

Executive Summary

Technical Report One focuses on the construction and planning methods as well as the building systems used on the Army National Guard Readiness Center (ArNGRC) project in Arlington, VA. The items contained in this report are as follows: project schedule summary showing the key milestones for the project, a building systems summary highlighting the major elements of the various building systems, a project cost evaluation consisting of a comparison of an RS Means estimate, a D4 parametric estimate, and actual project cost data, a site plan highlighting existing conditions on the site, local conditions for Arlington, VA, information about the client, a discussion of the project delivery system, and concludes with a report on the staffing plan used for the project.

A project schedule summary shows the key milestones for the project, starting with site clearance in December 2008 and concluding with owner acceptance in January 2011.

The building systems summary gives descriptions of each of the major building systems used on the project and highlights some of the key features in each system.

An evaluation of the cost of the project was done and a short analysis comparing the discrepancies between the RS Means and D4 parametric estimate and the actual project cost data is shown.

A site plan showing existing conditions of major utilities on-site, temporary utilities, existing building heights and locations, and general traffic around the site is provided.

A brief summary on the local conditions in Arlington, VA gives information on standard construction practices, average recycling and hauling fees in the area, and subsurface soil conditions for the site.

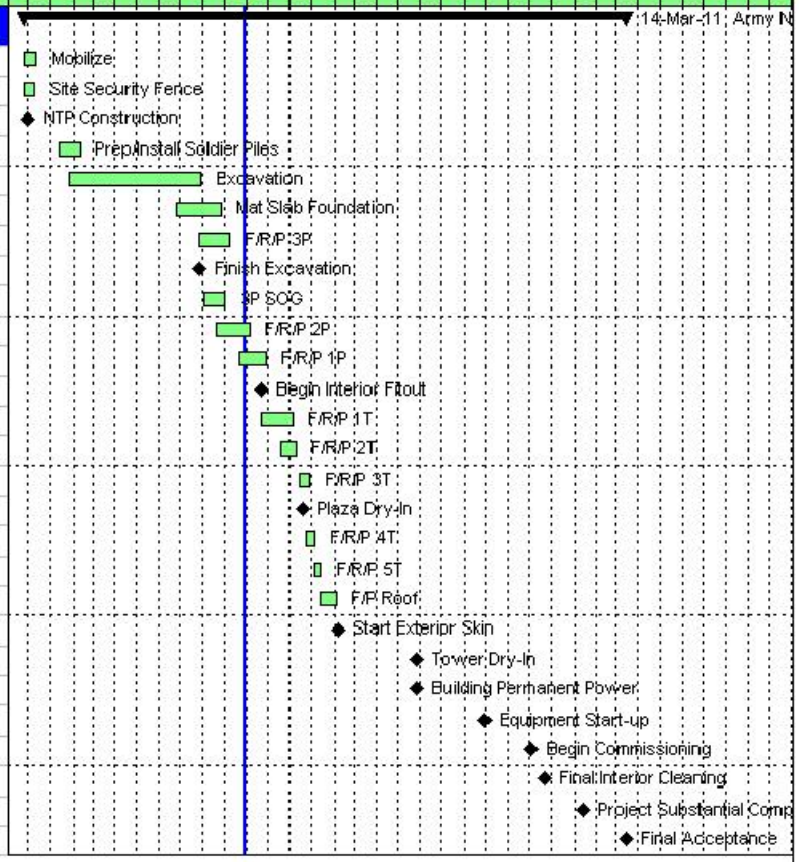
Information about the client is provided to give perspective as to why the project is being built. The owner is a government agency, however, so not much information is provided due to various security concerns and risks at the owner's request.

A design-bid-build delivery method is being used for the project and in the project delivery summary an evaluation is done of this delivery method and whether it is appropriate for this project. An organizational chart shows a layout for the major players associated with this project.

The report concludes with a staffing plan for the general contractor and an organizational chart showing the structure of the project management team.

Army National Guard Readiness Center | Classic WBS Layout | 30-Sep-09 15:43

Activity ID	Activity Name	Original Duration	Schedule % Complete	Start	Finish
	Army National Guard Re...	598	0%	26-Nov-08	14-Mar-11
A100	Mobilize	12	100%	26-Nov-08	11-Dec-08
A101	Site Security Fence	10	100%	26-Nov-08	09-Dec-08
A102	NTP Construction	0	100%	01-Dec-08	
A103	Prep/Install Soldier Piles	20	100%	14-Jan-09	10-Feb-09
A104	Excavation	130	100%	29-Jan-09	29-Jul-09
A106	Mat Slab Foundation	46	100%	26-Jun-09	28-Aug-09
A126	F/R/P 3P	30	100%	29-Jul-09	08-Sep-09
A105	Finish Excavation	0	100%		29-Jul-09
A107	3P SOG	20	100%	04-Aug-09	31-Aug-09
A108	F/R/P 2P	34	85.29%	20-Aug-09	06-Oct-09
A109	F/R/P 1P	26	19.23%	23-Sep-09	28-Oct-09
A124	Begin Interior Fitout	0	0%	21-Oct-09	
A110	F/R/P 1T	32	0%	22-Oct-09*	04-Dec-09
A111	F/R/P 2T	16	0%	18-Nov-09	09-Dec-09
A112	F/R/P 3T	11	0%	14-Dec-09	28-Dec-09
A116	Plaza Dry-In	0	0%		18-Dec-09
A113	F/R/P 4T	9	0%	23-Dec-09	04-Jan-10
A114	F/R/P 5T	8	0%	05-Jan-10	14-Jan-10
A115	F/P Roof	16	0%	14-Jan-10	04-Feb-10
A117	Start Exterior Skin	0	0%	05-Feb-10	
A118	Tower Dry-In	0	0%		26-May-10
A119	Building Permanent Power	0	0%	27-May-10	
A120	Equipment Start-up	0	0%	30-Aug-10	
A121	Begin Commissioning	0	0%	03-Nov-10	
A125	Final Interior Cleaning	0	0%		22-Nov-10
A122	Project Substantial Completion	0	0%		13-Jan-11
A123	Final Acceptance	0	0%		14-Mar-11

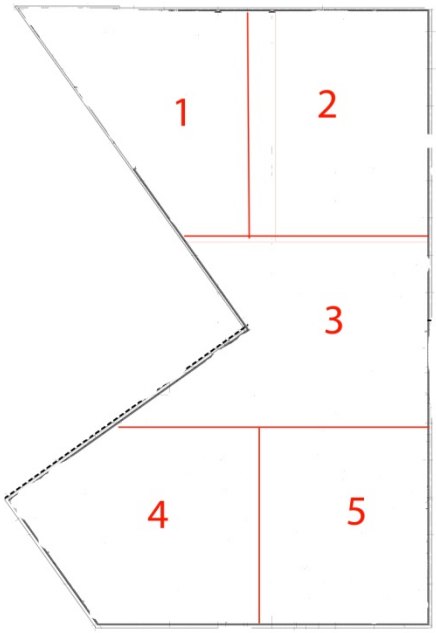


Actual Work | Critical Remaining Work | Remaining Work | Milestone

Produced by Arne Kvinnesland with the help of Tompkins Builders, Inc.

Construction Sequence Summary:

Foundation Sequence: The foundation is a mat slab foundation system. The building footprint is divided up into five areas and all work will progress along the same five-step sequence (see diagram below) throughout the entire project for all systems. Once excavation was completed through area 4 and the necessary compressive soil strength was achieved, foundation construction began. Concrete pours started once the crushed stone base was laid one area ahead and the pours were sequenced starting in area 1 through area 5.

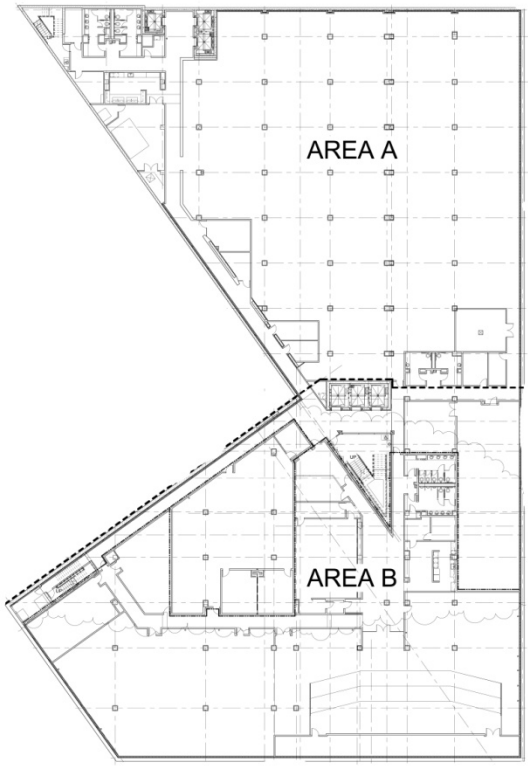


Superstructure Construction Sequence: The Army National Guard Readiness Center uses a cast-in-place concrete structural system with steel being used only for the major stair tower in the upper five floors of the building. The cast-in-place columns, beams, and walls supporting the floor above are poured prior to the floor slab of the current floor being poured. This is due to the fact that the rebar in all columns and walls is tied into the rebar of the floor slab and the floor slab concrete butts against the previously poured column concrete.

The most difficult part of the structure sequence comes when the upper five floors, referred to as the tower, are being constructed. For the tower, the steel ties into the concrete floor slabs and columns so steel for each floor must be erected just prior to the concrete for that floor being poured. Steel in concrete crews must work hand-in-hand in the same areas to ensure that this phase of the project goes smoothly.

Finish Construction Sequence: Interior fit-out is divided up into two major sections on each of the three lower floors: Area A and Area B (see diagram below). On these three lower floors, interior work will begin in the southern Area B and progress into Area A. This is due to the

tower being located above Area A so it gives structural crews time to work through the tower floors prior to interiors crews coming into the space below while still allowing Tompkins to manage interior work on the lower floors during tower structure construction.



The MEP systems in this building are extensive so the rough-in construction sequence will take detailed coordination to plan and execute. Rough-in work will take place in the standard sequence of ductwork first, plumbing piping next, finishing with mechanical piping, electrical conduit, and fire suppression systems last. Aside from conduit inside of the drywall partitions all of this work is located in the ceiling on each floor. Partitions locations will be laid out prior to MEP rough-in and then framed up, along with the grid ceiling, after the MEP systems have been installed.

As partitions are framed up, the drywall crew can come through each area of the building and hang drywall. Finally the painter can come through each space and paint the walls, the grid ceiling tiles can be installed, and the raised floor system tiles can be dropped into place.

Building Systems Summary

Required Demolition

Prior to start of construction, the site needed to be cleared of shrubs and certain areas were covered in trees that needed to be removed. There was also an antenna tower on site which needed to be relocated to another part of the site.

The Army National Guard Readiness Center is being constructed as an expansion to an existing facility on site. The ArNGRC will be attached to the existing structure by a small enclosed bridge walkway. To make this connection, a portion of the façade of the existing building needs to be demolished. The existing façade is architectural precast concrete with small portions of strip windows. On the interior of the existing building, where the bridge will connect, drywall partitions along with existing carpet floor need to be removed and demolished to create a hallway approaching the bridge.

Structural Steel Frame

Structural steel at the main stair tower in the tower portion of the project is a mixture of HSS type beams and columns. Rectangular beams are either HSS12x8x.625 or HSS14x4x.625 while columns are composite round HSS8.625x.322 or HSS11.25x.500. These steel beams tie into the cast-in-place concrete structure at each floor and must be erected at the same time as the concrete systems are poured all the way up the building.

Cast-In-Place Concrete

Other than at the main stair tower of the upper five floors of the building, the entire structure is cast-in-place concrete. The walls are designed to be laterally braced by the floor and roof systems and shear walls located throughout the building provide extra lateral support. Typical bay size varies from 20’x25’ to 20’x30’. Typical column size is 1’-10”x1’-10” with (8) #8 vertical reinforcement bars and #3 horizontal ties at 12” on-center.

Column and wall formwork are pre-constructed metal forms that are stripped and re-used all the way up the building. Horizontal slab formwork consists of plywood sheets with standard reshores.

Concrete slabs are poured via pump. The concrete subcontractor has 2-3 pump trucks located on site at all times which are mobile and can be relocated around the perimeter of the building to efficiently reach all slab areas. Columns and walls are being poured via crane and bucket.

Precast Concrete

There is architectural precast concrete located throughout the façade of the main building. The garage has precast concrete structural columns and slabs with cast-in-place exterior walls and slab-on-grade. There is a tower crane located at the parking garage site to place the structural precast members. There are also two tower cranes located at the main building site. These will be used to place the architectural precast panels but are located on-site throughout the entire project to place concrete and perform lifts for any trades necessary.

The structural precast concrete members are being cast in Winchester, VA. The architectural precast has not been awarded so no casting location is known currently.

Mechanical System

A hydronic HVAC system, consisting of a four-pipe heating and chilled water systems, distribute water to the air handling units (AHU) and variable air volume (VAV) terminal units on each floor and the energy recovery units in the mechanical penthouse. AHUs and VAVs are supplied by outdoor air and individual units are regulated by a Building Automation System (BAS). The BAS controls individual units, monitors temperatures in each space, and controls the fan coil units (FCU) around the building, as well.

Each floor has a mechanical room where AHUs are located with individual VAVs and FCUs spaced throughout the floors. On the roof there is also a mechanical penthouse that houses emergency backup generators and the energy recover units.

The sprinkler system is supplied by two hydrants providing a 1520 GPM flow rate. These hydrants are supplied by waterlines that are tapped into the existing water main on the nearby street. The building will employ both a Light Hazard, providing 0.10 GPM over 3000 square feet, and an Ordinary Hazard system, providing 0.20 GPM over 3000 square feet.

The main server room in the building employs a FM-200 system. FM-200 is a colorless, non-toxic gas that is stored in two 300 gallon cylinders which will release into the room and extinguish a fire within 10 seconds of detection. It is a clean product that will only minimally damage the equipment in the server room compared to a sprinkler system employing water, which will destroy the electrical components.

Electrical System

Power comes into the site at 35.4kV, supplied by the local power company. ArNG has a switchgear which steps it down and feeds power into the building with 2 medium voltage feeders at 15kV each. These feeders connect to substations within the main building, where

power is stepped down again to a 480/277, 3 phase, 4 wire system. Lighting systems are fed by 208/120, 3 phase, 4 wire panelboards.

Two 1500 kW diesel-powered generators located on the roof penthouse level supply emergency power to the substations located on the lower level. A large conduit riser goes down 7 stories through the building and cuts east-west across the second story to connect to the substation room.

Lighting: ArNG will be lit by fluorescent lamps (277V) and incandescent lamps (120V). Programmable lighting relay systems will control all of the open office areas. Dimmable lighting fixtures are provided in some of the smaller offices around the perimeter of the Operations Center. Automatic controls will cover the rest of the lighting.

Curtain Wall

The curtain wall consists of aluminum framing with multiple glazing types. The glazing for this project has not been submitted yet so exact types are unknown currently, but there are both LEED and blast resistance requirements built into the specifications for the project that make it a fairly unique and complex curtain wall system. Due to security issues, the Army National Guard does not want the blast requirements for the glazing revealed so those features will not be reported here.

Support of Excavation

Only small portions of the utility installation on-site for the project require any shoring. Both the main building and the parking garage have multiple below-grade stories and large amounts of excavation are needed. The excavation support systems consist of soldier piles with lagging boards placed as the site is excavated. Grouted tie-backs are drilled and installed every 10-12' of excavation.

A unique feature of this project appears at the garage: a secant-pile wall permanent excavation support. The secant-pile wall is placed between the new garage and the garage existing on site. Due to the close proximity of these two structures to each other and the depth of the excavation for the new garage, a more advanced excavation support system was needed than the standard lagging.

An extensive temporary dewatering system was needed both at the main building and the garage. Due to the depth of excavation at both sites, the water table needed to be lowered a considerable amount. There was an extensive amount of water coming into the site and approximately 20 dewatering pumps were installed around the perimeter of the main building site to deal with the water.

Project Cost Evaluation

Actual Project Cost Information

With the information obtained from the general contractor it is practically impossible to come up with an accurate building CC/SF. The information supplied by the general contractor has the budget and estimate for the project broken down by CSI division across the entire project without differentiating between the building systems and the parking garage systems. Due to this, all of the costs are lumped together and represent both. Without doing a detailed estimate/budget analysis, an accurate building CC/SF cannot be calculated. The total project CC/SF will be accurate and give a good representation of the project as a whole. Keep this in mind as the following information is reviewed.

Total Building Cost:

Total Building Square Footage: 251,444 SF

Total Parking Garage Square Footage: 173, 335 SF

Construction Cost (building + garage): $73,314,757

Total Project Cost:

Total Project Square Footage: 424,779 SF

Total Project Cost (before fees): $84,045,024

TC/SF: $197.86

The MEP systems in the parking garage are minimal compared to the building systems, so the following are fairly accurate cost/square foot values for the project.

Mechanical System (HVAC, fire protection): $43.98/SF

Electrical: $55.25/SF

Structural System (concrete, masonry, structural steel): $49.63/SF

The structural system total project cost/SF was done for both the building and garage due to the majority of the structural system cost coming in the form of cast-in-place and precast structural concrete, both of which are used extensively in the building and parking garage.

D4 Cost Estimate

Using D4 Cost Estimating software, a parametric estimate was developed for the Army National Guard Readiness Center project. A project selected from a historical database was selected that most closely resembled my project. Escalation of cost due to time was adjusted to 2008 as well as the square footage increased to represent the ArNGRC. The D4 estimate came up short of

the actual building cost due to a lack of a federal office building project plus a parking garage in the historical database. The actual parking garage cost being added would make up the difference in estimates.

Parametric D4 Cost Estimate				
Code	Division Name	%	Sq. Cost	Projected
02	Site Work	15.14%	40.16	10,097,991
03	Concrete	25.54%	67.78	17,042,874
04	Masonry	0.63%	1.68	422,426
05	Metals	4.18%	11.08	2,786,000
06	Woods & Plastics	1.10%	2.91	732,717
07	Thermal & Moisture Protection	1.99%	5.28	1,327,624
08	Doors & Windows	0.57%	1.51	379,680
09	Finishes	9.84%	26.11	6,565,815
10	Specialties	1.71%	4.53	1,139,821
11	Equipment	0.14%	0.38	95,468
12	Furnishings	0.00%	0	0
14	Conveying Systems	3.33%	8.83	2,220,251
15	Mechanical	15.01%	39.84	10,017,529
16	Electrical	20.82%	55.24	13,889,767
	Total Building Costs	100.00%	265.33	66,717,963

RS Means 2009 Cost Estimate

To develop an RS Means building cost estimate, RS Means – Cost Works online service was used. Two different estimates were done to account for both the building and the parking garage. RS Means does not have an accurate building type to account for a federal office building with the same building systems as the Army National Guard Readiness Center. ArNGRC has training facilities, a small auditorium, and high-end security systems along with the standard office space. No RS Means building type encompasses all of those systems so it was not expected to produce an accurate building cost estimate for this type of project.

The two RS Means building cost estimate summaries developed online can be seen below. RS Means came up with a $109.45/SF for the main building and a $37.11/SF for the parking garage. Until a detailed estimate analysis can be done to separate the building and parking garage within the budget supplied by the general contractor, it is difficult to determine whether these cost/SF estimates are accurate.

Model:	**Office, 5-10 Story with Precast Concrete Panel / R/Conc. Frame**
Location:	**ARLINGTON, VA**
Stories (Ea.):	**8**
Story Height:	**12.00**
Floor Area:	**251,444**
Basement:	**No**
Additive Cost:	**$701,046.00**
Cost per square foot:	**$109.45**
Building Cost:	**$27,520,500.00**

Model:	**Garage, Parking with Precast Concrete / R/Conc. Frame**
Location:	**ARLINGTON, VA**
Stories (Ea.):	**5**
Story Height:	**10.00**
Floor Area:	**172,335**
Basement:	**No**
Additive Cost:	**$0.00**
Cost per square foot:	**$37.11**
Building Cost:	**$6,395,000.00**

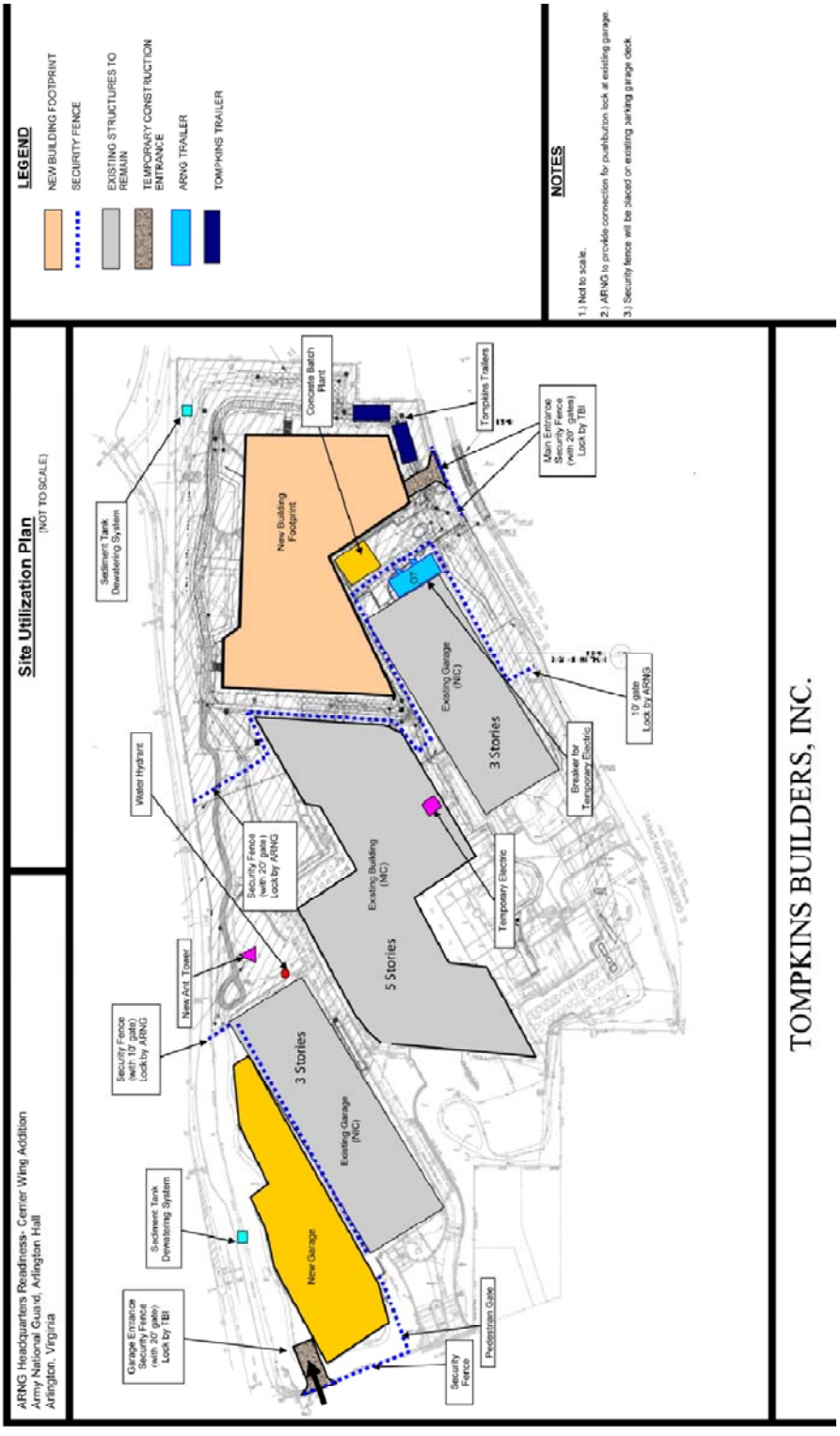
Total RS Means Estimated Cost: $33,915,500

This RS Means estimated cost comes up $50,000,000 short of the actual project costs. This can be directly attributed to the RS Means data not accounting for multiple aspects of the ArNGRC project:

- This is a highly technical facility when compared to the standard office building data that RS Means uses. There are extremely high demands on the electrical system, the security system is very intricate, and the audio-visual and telecom systems are extensive when compared to a standard office building. The Army National Guard Readiness Center also contains some very unique features when compared to a standard office building. ArNGRC contains an auditorium, training facilities, operations center, locker rooms, mechanical rooms and AV/Telecom/Security rooms located on every floor. RS Means has no data to accurately estimate a federal office building like the ArNGRC, leading to a large discrepancy between the estimates.

- The building façade is much more involved than a standard office building. The façade consists of architectural precast concrete panels and curtain-wall glass. RS Means data accounts for a standard glass curtain-wall façade. The glass for the ArNGRC façade has blast resistance requirements as well as LEED requirements so is more expensive than a standard glass façade. Architectural precast is also more expensive than standard glass. These two things combined leads to another large discrepancy between the actual project cost estimate and the RS Means data collected.
- A unique architectural feature of this building is a steel tricorn placed at the top of the stair tower which was added as a bid option by the owner. This is something that RS Means cannot account for in its standard office building data.

Site Plan


ARNG Headquarters Readiness- Center Wing Addition
Army National Guard, Arlington Hall
Arlington, Virginia
Site Utilization Plan
(NOT TO SCALE)
LEGEND
NEW BUILDING FOOTPRINT
SECURITY FENCE
EXISTING STRUCTURES TO REMAIN
TEMPORARY CONSTRUCTION ENTRANCE
ARNG TRAILER
TOMPKINS TRAILER
NOTES
1.) Not to scale.
2.) ARNG to provide connection for pushbutton lock at existing garage.
3.) Security fence will be placed on existing parking garage deck.
Sediment Tank Dewatering System
Concrete Batch Plant
Tompkins Trailers
Main Entrance Security Fence (with 20' gates) Lock by TBI
New Building Footprint
OT
Existing Garage (NIC)
3 Stories
10' gate Lock by ARNG
Water Hydrant
Security Fence (with 20' gate) Lock by ARNG
Existing Building (NIC)
5 Stories
Breaker for Temporary Electric
Temporary Electric
New Ant Tower
Security Fence (with 10' gate) Lock by ARNG
3 Stories
Existing Garage (NIC)
Sediment Tank Dewatering System
New Garage
Garage Entrance Security Fence (with 20' gate) Lock by TBI
Pedestrian Gate
Security Fence
TOMPKINS BUILDERS, INC.

Local Conditions

The Army National Guard Readiness Center is a cast-in-place concrete structure, which is fairly typical for the general area in Arlington, VA. Cast-in-place concrete and structural steel are the two most common structural types in the area. ArNGRC also employs a deep foundation system, which is not common for the immediate vicinity. The majority of local projects are shallow foundation projects. There are deep foundation systems on projects in the busier parts of Arlington, but ArNGRC is located near residential areas more so than near other large-scale construction projects.

Construction parking has not been an issue so far on the project due to its early nature and not many subcontractors being on site yet. However, once the project really kicks in there is going to be a significant parking shortage. Currently, there is parking along the street in front of the site and at a public park across the street, but the spots are limited. There is parking available on site for 10-12 vehicles at a time spaced out around the entire site and are usually used by the project managers and lead superintendents of all the subcontractors.

Local tipping fees range from $65.00/ton to $85.00/ton. There are multiple recycling locations within 30 miles of the project site where waste can be hauled to meet LEED credits.

Soil conditions in the area are a mixture of clay and sand. The mixture, when moist, creates almost a spongy soil type, which makes it difficult to achieve necessary bearing capacity for the building foundation systems. The site has an unknown source of water flowing into it from multiple sides, making it very difficult to keep the excavation dry. Research is being done into whether a local water main could be cracked. There is no history of an underground spring in the area, but the idea has not been ruled out as a possible source for the fairly constant flow of water coming into the site.

Client Information

The owner of this project is the Army National Guard. They are building this facility as an expansion to an existing facility on site. It is going to function as an administrative office building. The capacity of the existing facility is currently being exceeded by a considerable amount. Most of the office spaces in the new building are going to be filled immediately once construction is complete.

As it is with most construction projects, safety is a primary concern for everyone involved. It is standard practice for construction projects to have safety plans on site and this project is no different. Safety is monitored by the general contractor on site.

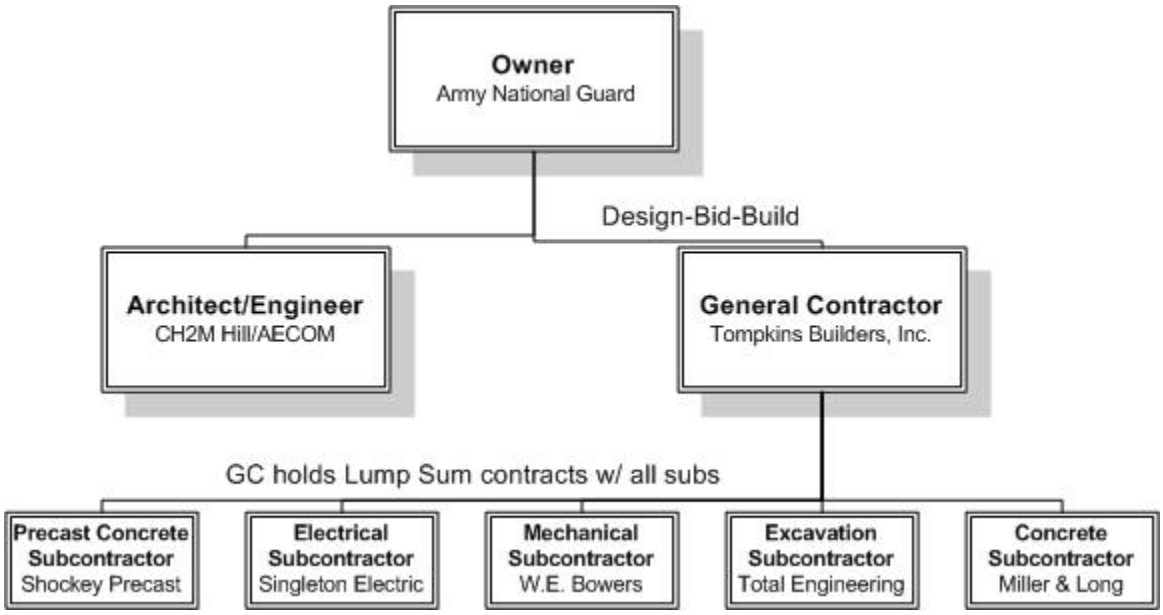
The Army National Guard is very concerned about the quality of construction of this project. There are many high-end security, audio-visual, and telecom systems built into this project. There are also blast radius and blast resistant material requirements for the façade of the building. As a federal organization, security is of utmost importance to the owner and the systems involved must be of the highest quality.

Note: Due to the project being a federal building and the owner being a military organization, not much can be revealed about the major concerns to the owner and all of their reasons to build the facility. Everything written above comes directly from assumptions and observations made by Arne Kvinnesland during his time spent working on site with the general contractor.

Project Delivery System

The Army National Guard holds a Design-Bid-Build contract with Tompkins Builders, the general contractor. As the owner, the Army National Guard mandated that this be the delivery system used. This is not Tompkins preferred method of project delivery, however. Tompkins prefers doing more Design-Build work because it is more efficient and effective. They prefer to manage the design team instead of having the owner perform this task. This makes communication even more vital between the design team and the general contractor to meet the owner's needs and deliver a successful project.

The organizational chart for the Army National Guard Readiness Center can be seen below.



Tompkins Builders holds lump sum contracts with all of the subcontractors on the project except for the inspector, surveyor, schedule consultant, and utility locator. Subcontractors submit lump sum bids which Tompkins then review and evaluate prior to awarding the contract to the subcontractor for a specific area of the project. This allows Tompkins to mandate specific contractual items (such as Building Information Modeling capabilities) with each subcontractor. It also allows Tompkins to evaluate baseline bid cost vs. quality of work with each bid based on subcontractor past performance, giving them the opportunity to select the most appropriate subcontractor to perform the work.

The Design-Bid-Build delivery method, stipulated by the owner, carries with it several critical items to deliver a successful project. A complete and accurate set of drawings, provided by the

design team, is needed to accurately bid the project. Any inconsistencies with the drawings that were originally bid by the general contractor can lead to design and cost changes later in the project. A good relationship between owner, architect/engineer, and general contractor is needed to successfully manage design and price changes throughout the project to eliminate or minimize conflict within the team. Any conflicts within the team can cause the project schedule to slip and needs to be managed efficiently.

For this project, a Design-Build delivery method may have been more appropriate to deal with changes and drawing inaccuracies. This building has high-end security, electrical, and mechanical systems associated with it, much of which was changed during the coordination process early in the project, leading to cost changes. Since the project was bid based on the original set of contract documents, a price has already been set for individual systems and cost changes create issues with the owner.

Staffing Plan

Tompkins Builders has an operations manager and a project executive assigned to the project, both working out of the main office. They both have multiple projects that they are involved with and are not assigned solely to the Army National Guard Readiness Center project.

The on-site staff starts with the project manager on down the organizational chart below. Directly under the project manager are two assistant project managers: one in charge of cost and the other in charge of quality control. In addition to the project management team there are three project engineers on-site: one MEP engineer, one structural engineer, and one general engineer.

The management team also includes a general superintendent, superintendent, two assistant superintendents, and an MEP superintendent supervising in-field work and reporting directly to the project management team.