Technical Assignment Three

Penn State AE Senior Thesis

Image courtesy of U.S. Army Corps of Engineers

Advanced Individual Training

A.I.T. Barracks

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Executive Summary

The Advanced Individual Training (A.I.T.) Barracks is a three story building with a progressive collapse avoidance structural system. The owner of the building is the U.S. Army Corps of Engineers. The building envelope has precast accents and a brick veneer (non load bearing) façade. A.I.T plans to house a total of 300 soldiers in 150 sleeping modules. This 91,800 S.F. building will cost approximately 18,166,185 dollars when the project is finished in February of 2012. The building has many unique features not present in a normal Barracks, e.g., the building lacks an elevator. Although the building has many unique features no unusual techniques were implemented. LEED Silver is the current goal of the project, which the project is projected to successfully achieve it.

Technical assignment three will identify areas of the project that are good candidates for research, alternative methods, value engineering, and schedule compression.

The three constructability challenges discussed in this report are installing the hollow metal door frames, coordination issues between underlayment manufacturer and resilient flooring manufacturer, and the issue of water infiltrating the building.

Schedule Acceleration was used on this job in several ways, for example overtime was necessary to keep the schedule on target due to the aggressiveness of the schedule completion date.

Value Engineering was not directly implemented on this project since the project was a design-build method and the value was incorporated into the decisions. Two possible value engineering ideas discussed are switching to MC-cable and eliminating a stair case. These ideas were not successful in becoming part of the building.

The critical industry issues including IPD and sustainability were discussed.

Problem Identification and Technical Analysis's are discussed in more detail in the analysis that follows.

Table of Contents

Executive Summary ---- 2
Table of Contents ---- 3
Constructability Challenges ---- 4
Schedule Acceleration Scenarios ---- 7
Value Engineering Topics ---- 9
Critical Industry Issues ---- 10
Problem Identification and Technical Analysis Options ---- 12
Appendix A - Resilient Flooring (Section 09 65 00) ---- 17
Appendix B - Interior Finish Specifications ---- 25
Appendix C - Armstrong Commercial Installation Guide ---- 27
Appendix D - PACE Roundtable Worksheet ---- 32

Constructability Challenges

The A.I.T. Barracks project had numerous constructability challenges to face when being constructed. One of the challenges was figuring out how to install welded hollow metal frames in a pre-fabricated engineered panel system wall while being limited to blast and progressive collapse system requirements. Another consideration that needed to be addressed was the spacing for the resulting A36 steel required. This requirement directly affect how the hollow metal frames were installed in the walls. Do to the spacing limitations, identified by the blast and progressive collapse system requirements, the rough openings were not able to be oversized to enable infill of studs. Figure 1 shows a typical rough opening for a typical hollow metal frame which is highlighted in purple. After consulting with the door manufacturer, it was found that a clip detail could be manufactured to be welded to the frame. This clip detail would have straps that extended out and be welded to the A36 steel that was in the panel walls. This detail can be seen in Figure 2 highlighted in purple.

Fig 1. Rough opening for hollow metal frame

Fig 2. Clip detail added to hollow metal frame

Constructability Challenges

Another constructability challenge the A.I.T. Barracks project team is currently facing is figuring out how the floor underlayment and finish floor materials, vinyl composition tile (VCT) coincide. According to the specifications, resilient flooring (section 09 65 00) ASTM F 1482 is required to be implemented. (Specification section 09 65 00 has been attached in Appendix A for reference.) The ASTM F 1482 standard can be defined as "providing minimum recommendations for the installation and preparation of wood-based, fiber-reinforced gypsum and fiber-cement panel underlayments suitable to receive resilient floor coverings." The underlayment used in this project is to be determined. The challenge currently at hand is that the underlayment manufacturer and the finish floor manufacturer are not coordinating with one another.

The underlayment manufacturer being used is Tarkett. The material Tarkett is providing limits the static loading to 50 psi when installing their VCT over their underlayment and also states no caster loading (one four legged chair will exceed the static load on 50psi).

The finish floor manufacture being used for the interior finishes (VCT) is Armstrong Commercial. The interior finish specifications being implemented on the A.I.T Barracks regarding VCT can be seen in Appendix B. Armstrong Commercial has very strict requirements for substrates as well as underlayment. These requirements were found after reviewing the installation guide provided in Appendix C. The substrate used on the A.I.T. Barracks is concrete, which is an acceptable substrate. However, the underlayment used to create a smooth substrate for the new floor is not acceptable. The acceptable underlayments can be seen in Appendix C. Also Armstrong Commercial will not give a warranty for their finished floor over top a different manufacture's underlayment. This constructability challenge is currently under review and is not resolved.

Constructability Challenges

A major constructability challenge that is being immediately addressed is water infiltration at windows, flashing, masonry, and air barrier details. Water is also infiltrating at the roof flashing details, this detail can be seen in Figure 3.

The water infiltrating at the windows, flashing, masonry, and air barrier details is still being resolved no one solution has been found. However, after encountering these challenges some lessons learned can be acknowledged:

- When sealant installation and flashing details such as windows and masonry are being installed, quality control needs to be strictly monitored.
- All fastener penetrations in the exterior wall need to be fully sealed. The A.I.T. Barracks uses exterior spray foam insulation, this insulation may help repel water, but is not guaranteed to keep all moisture out of the building.
- Make sure all seams in exterior sheathing that would be behind lintels are sealed.

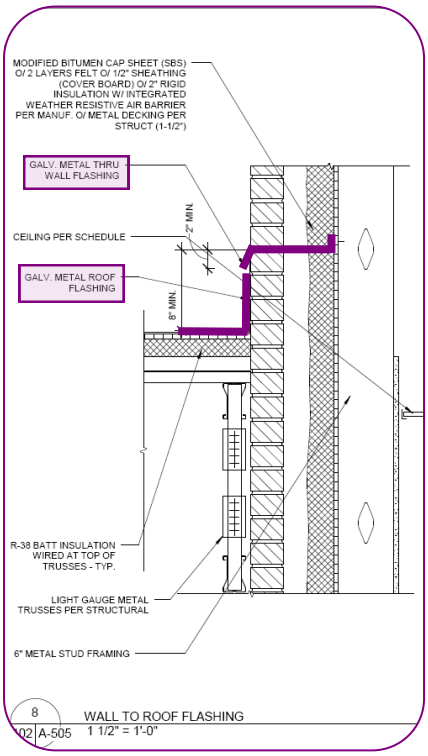


Fig 3. Original Wall to Roof Flashing detail

The water infiltrating at the roof flashing details has been resolved. The solution to this problem was to revise many details and complete the design in the field to incorporate through wall flashing. Metal trim/ flashing is also being extended down from the metal gable caps to lap over the top of the roof flashing. This is to cover up the masonry on the sides of the gables with metal in an effort to seal the tops.

A detail of the revised through wall flashing is currently being requested

Schedule Acceleration

The critical path started with earthwork and moved to foundations, the structure, and finally interior finished. The critical path changed to the exterior site work due to a delay in start from the owner's utility contractor. This affected the start of all the final site activities (paving/fine grading/soft scape). The critical path is depicted in Figure 4.

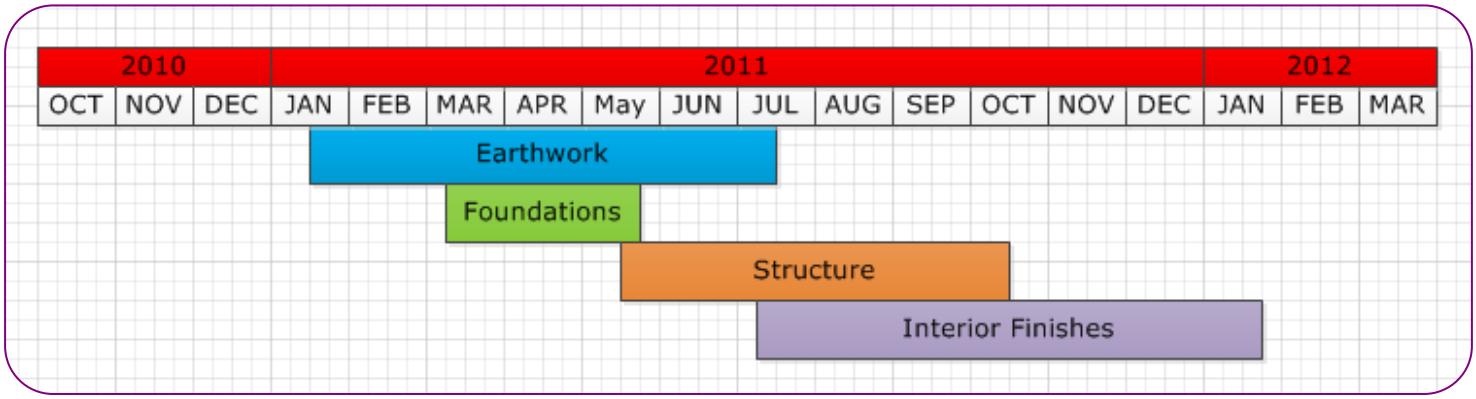


Fig 4. Critical Path

The biggest risks to the project completion date are as follows:

- Weather
  - During the month of September hurricane and tropical storm rains were devastating to the project schedule.
- Unforeseen conditions
  - The project began with a real-estate issue that resulted in a delay in the project. Balfour Beatty Construction requested an extension of time for the project and was granted 21 days based on this issue.
  - Geotechnical work
- Subcontractor's meeting dates that were committed to.

Schedule Acceleration

The schedule needs to be accelerated in order to partially mitigate a portion of the owner's utility start delay. Re-sequencing sections of the site paving activities has accelerated the schedule in a positive way. This was done by overlapping some of the paving activities. The schedule has been further accelerated by working every weekend since the start of the project. This is due to the extremely aggressive schedule set from the beginning of the project.

The cost implications on the project regarding re-sequencing site activities were none. Since the activities were already on the schedule, the cost to the project of re-sequencing did not increase or decrease the final price. However, working every weekend involves overtime, which has increased the cost of the project. If an issue was not due to a subcontractor’s own issue, compensation was provided to reimburse their lost time.

Value Engineering Topics

The A.I.T. Barracks project uses a design-build delivery method approach. When using this method very few value engineering areas/ideas were implemented or discussed because the value was built into the decisions made on the project. This project also had requirements regarding the Center of Standardization (CoS). The U.S. Army Corps of Engineers states that "the standardization of facilities will result in more consistent solicitations via standard Requests for Proposal (RFPs). This will reduce contractor uncertainty about requirements for like facilities from installation to installation, as well as provide for more productive time spent on proposals. And the standardization of product and facility types will allow us to focus more on actual construction and delivery." This statement additionally limits the value engineering able to be incorporated.

One of the value engineering ideas recommended was using MC-cable instead of hard conduit to run electrical through-out the building. This resulted in some use of MC-cable, but this was not adopted by the government as a value engineering option. The issues related to maintenance/troubleshooting of MC-cable was the basis of this decision.

Another value engineering idea was to eliminate the center stair case seen highlighted in Figure 5. This stair case was not needed for fire safety and was thought to "waste" space. However, the owner did not approve this exclusion.

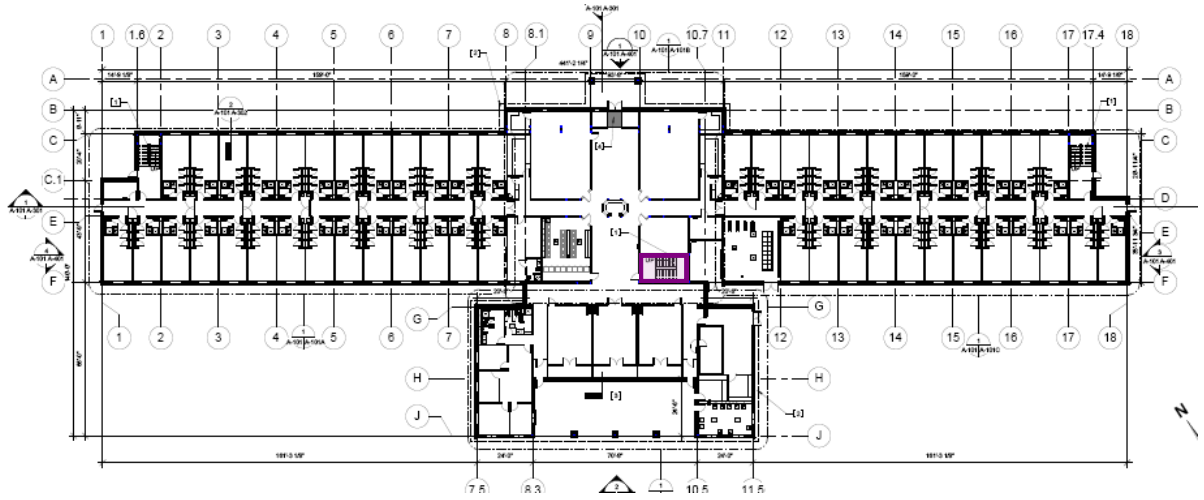


Fig 5. First floor plan highlighting the center stair case

Critical Industry Issues

The PACE Roundtable sessions focused on sustainability/green building, process innovation, and technology. The combination of industry members and students collaborating in the sessions provided excellent conversation. The sessions attended included assembling/procuring an integrated team and learning systems for training a sustainable workforce.

Assembling/Procuring an Integrated Team:

Throughout this session many topics were discussed regarding the integrated project delivery (IPD) method. Questions arose such as how do you get the contractors involved early and how can you make decisions sooner? Although these questions were not answered during this session they were the starting point for a great discussion. During this discussion, the method of introducing the IPD concepts into industry by building trust and respect was favored. Another common theme was the issue of finding value when convincing the owner to use an IPD contract. What risk is involved for the owner in the IPD contract? Moreover, due to each project having a different need, the idea of finding common elements across the board (i.e. MEP, Curtain wall, Structure.. Etc) was discussed as well. Does the design team ultimately want to be integrated together? These statements and questions were just a few deliberation points that were made during the session.

This discussion sparked my interested and invoked thoughts about the key areas of research. The most viable area of research in my opinion, would be to research the contracts. With my project being a design-build delivery method it would be relatively simple to implement IPD. Comparing the two documents side by side and understanding the risk for all parties involved could be very valuable when negotiating project delivery types in the future. Identifying the sources of risk and how the risks differ among each person involved could be a viable risk analysis.

Another area of research that could be considered could be an analysis of the integration between design-bid-build, design-build, and IPD. Visual aids could be assembled to better understand when (on average) personnel join the project, how the deliver methods differ, and which method would be best for my project.

Critical Industry Issues

Learning Systems for Training a Sustainable Workforce:

During this break out session the question what is a sustainable workforce was defined. A sustainable workforce was defined as the following: lean construction, continuous learning, merging technology with practice and paperless. The next topic discussed the question of who the sustainable workforce was.? The answer to this question was discussed, but not clearly defined. some persons included though are the owner, maintenance team, operations, and target field staff. Improvement to the workforce were also discussed, leading to the biggest topic discussed: behavioral attributes. These attributes could be team work, passion, positive attitude, listening, and communicating.

A research topic discussed during this session was investigating strategies to maintain a team atmosphere throughout the project. This research would involve surveying the field to find out how expectations and goals were reached and met. Questions such as were milestones arrived at on time could be asked. This question could be asked because milestones are such an important part of the project. As a team atmosphere might have not been maintained during these milestones.

another possible research topic is to look at the different parts of sustainable workforce, such as A/E, CM/GC, and Owner. What are the strengths and weaknesses? How are the strengths managed, do these strengths cause synergy or conflict within the workforce? Also considering each individual part, who drives the project could possibly be determined.

Problem Identification and Technical Analysis Options

Analysis 1:

Implementing a Short Interval Production Schedule (SIPS)

The A.I.T. Barracks project ran into unforeseen conditions. To accelerate and get the schedule back on schedule, a SIPS schedule could be implemented. This implementation could be very beneficial to the project, as it has very repetitive activities/tasks. A SIPS schedule is creates a assembly line mentality, creating consistent incremental schedule blocks.

The analysis and research needed to implement a SIPS:

- Fully understand how a SIPS method works
- How the non-repetitive areas would be handled
- What trades would be in a consistent "block"

The types of design and construction analyses required are as follows:

- How much could this accelerate the schedule
- What cost saves could be made
- What overtime could be eliminated

Breadth:

Structural

Could the structural system be changed to easi-wall (a sandwich insert) to accelerate the schedule?

Breadth:

Architectural

Could the brick veneer be prefabricated to accelerate the schedule?

Problem Identification and Technical Analysis Options

Analysis 2:

Comparing the A.I.T. design-build contract to an IPD contract and the involved risk

The A.I.T. Barracks project is being completed using a design-build method approach. With IPD being a hot topic among industry, the delivery method has a lot to be desired. However, this method is not being implemented to its full potential. One possible reason for this lack of use could be from the risk involved. Analyzing the risk from the design-build contract used in A.I.T. and the risk associated with an IPD contract could give pros and cons as to why the IPD method approach was not used, as well as give reasons as to why the IPD method approach should have been used.

What analysis, and research is needed to compare the two contracts:

- Obtain the documents A.I.T. design-build contract and IPD AGC consensus contract
- Review line by line to see the difference between contracts
- Understanding ownership of risk
- Understand the risk differs between parties
- Find reasons why IPD not used and how it could be used
- Review how could IPD benefits the project

The types of design and construction analyses required are as follows:

- Using an IPD method could the schedule be reduced
- What coordination issues could have been avoided

Problem Identification and Technical Analysis Options

Analysis 3:

LEED Silver to LEED Gold

This project is currently on the path to achieve a LEED Silver certification. The Us. Army Corps of Engineers (USACE) has a minimum requirement for all new construction starting after 2008. This requirement has driven the project to become LEED Silver with 52 points. Researching to see what requirements are needed to achieve LEED Gold could give the USACE a more efficient and prestigious building.

What analysis, and research is needed for the project to become LEED Gold:

- Understand the LEED system in more detail
- Locate any points that have been achieved but not accounted for
- Obtain industry contacts to see what is actually being used in industry
- Re-calculate the LEED points on the score card

The types of design and construction analyses required are as follows:

- What are the pay back periods for any new appliances or systems
- Is there a premium to pay for LEED Gold

Breadth:

Electrical

Changing the lamps/light fixtures to be more efficient

Breadth:

Plumbing

Changing the piping to a more economically-friending pipe such as aquatherm greenpipe.

Problem Identification and Technical Analysis Options

Analysis 4:

Analyzing the effects of modularization

The A.I.T. Barracks complex is very repetitive and standardized. Modularization of the building has the possibility to lead to an earlier completion date that is under budget, and in turn exceeds expectations. All of the attributes can benefit the project in many ways. Modularization can also lead to higher costs, which may be due to the need for more equipment to set the modular. This project did not consistently use a crane, which when added to the budget could increase cost significantly.

Analysis and research needed for analyzing the effects of modularization:

- What sections of the building can be modular
- How would non-modular sections be constructed

Types of design and construction analyses required are as follows:

- Would a crane need to be brought on site to place the modular units
- What impact would modularization have on the schedule
- Would the impact on schedule be negative or positive
- Would a cost increase be endured on the project
- Would the cost impact be because of the crane

Problem Identification and Technical Analysis Options

Analysis 5:

Researching underlayments of VCT resilient flooring

Current A.I.T. Barracks project constructability challenges include underlayments of VCT resilient flooring. The use of two different manufacturers for the underlayment and VCT is causing this issue. Researching why two different manufacturers were used could speed up the schedule and reduce cost. This could be because the problem wouldn't occur.

Analysis and research needed for understanding underlayments:

- What types of underlayments are available
- Why were two different manufacturers used

Types of design and construction analyses required are as follows:

- Would the cost decrease if the same manufacturer was used
- Could schedule speed up if the same manufacturer was used
- How could this problem have been avoided

Breadth:

Architectural

Changing the VCT resilient flooring

Appendix A:
Resilient Flooring (Section 09 65 00)

SECTION 09 65 00

RESILIENT FLOORING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 4078	(2002; R 2008) Water Emulsion Floor Polish
ASTM D 5603	(2001; R 2008) Rubber Compounding Materials - Recycled Vulcanizate Particulate Rubber
ASTM E 2129	(2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM F 1066	(2004) Standard Specification for Vinyl Composition Floor Tile
ASTM F 1482	(2004; R 2009e1) Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring
ASTM F 1861	(2008) Resilient Wall Base
ASTM F 1869	(2009) Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F 2170	(2009) Determining Relative Humidity in Concrete Floor Slabs in situ Probes
ASTM F 710	(2008) Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring

GREEN SEAL (GS)

GS-36	(2000) Commercial Adhesives

GREENGUARD ENVIRONMENTAL INSTITUTE (GEI)

GEI	Greenguard Standards for Low Emitting Products

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	Scientific Certification Systems

(SCS)Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(1989; R 2005) Adhesive and Sealant Applications

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.2 SYSTEM DESCRIPTION

1.2.1 Local/Regional Materials

See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local/recycled material requirements. Flooring materials may be locally available. Flooring and accessories may contain post-consumer or post-industrial recycled content.

1.2.2 Environmental Data

Submit Table 1 of ASTM E 2129 for the following products:

1.2.3 Other Submittal Requirements

The following shall be submitted in accordance with LEED:

a. documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

b. documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

c. documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

d. documentation relative to local/regional materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

e. documentation relative to recycled content credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

f. documentation relative to low-emitting materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

g. documentation relative to rapidly renewable materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Resilient Flooring and Accessories

SD-03 Product Data

Resilient Flooring and Accessories

Adhesives; (LEED)

Vinyl Composition Tile

Wall Base

Local/Regional Materials

Environmental Data

Certification

Recycled Content

Regional Material

Volatile Organic Compounds (VOC)

SD-04 Samples

Resilient Flooring and Accessories

SD-06 Test Reports

Moisture, Alkalinity and Bond Tests

SD-08 Manufacturer's Instructions

Surface Preparation

Installation

SD-10 Operation and Maintenance Data

Resilient Flooring and Accessories

SD-11 Closeout Submittals

Local/Regional Materials

Resilient Flooring and Accessories

Adhesives

Sheet Linoleum

Linoleum Tile

Cork

1.3.1 Recycled Content

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

1.3.2 Regional Material

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

1.3.3 Volatile Organic Compounds (VOC)

Submit manufacturer's product data, indicating VOC content of sealants, adhesives, primers, and coatings applied on site.

1.4 SUSTAINABLE DESIGN CERTIFICATION

Product shall be third party certified by GEI Greenguard Indoor Air Quality Certified, SCS Scientific Certification Systems Indoor Advantage or equal. Certification shall be performed annually and shall be current.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, production run, project identification, and handling instructions. Store materials in a clean, dry, secure, and well-ventilated area free from strong contaminant sources and residues with ambient air temperature maintained above 68 degrees F and below 85 degrees F, stacked according to manufacturer's recommendations. Remove resilient flooring products from packaging to allow ventilation prior to installation. Protect materials from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Observe ventilation and safety procedures specified in the MSDS. Do not store VCT near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.6 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive resilient flooring at a temperature above 68 degrees F and below 85 degrees F for 3 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. Maintain a minimum temperature of 55 degrees F thereafter. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

1.7 SCHEDULING

Schedule resilient flooring application after the completion of other work which would damage the finished surface of the flooring.

1.8 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

1.9 EXTRA MATERIALS

Provide extra flooring material of each color and pattern at the rate of 2 percent installed. Provide extra wall base material composed of 20 linear feet of each type, color and pattern. Package all extra materials in original properly marked containers bearing the manufacturer's name, brand name, pattern color name and number, production run, and handling instructions. Provide extra materials from the same lot as those installed. Leave extra stock at the site in location assigned by Contracting Officer.

PART 2 PRODUCTS

2.1 VINYL COMPOSITION TILE TYPE 1

Conform to ASTM F 1066 Class 1, 1/8 inch thick. Provide color and pattern uniformly distributed throughout the thickness of the tile.

2.2 WALL BASE

Conform to ASTM F 1861, Type TS (vulcanized thermoset rubber) or Type TP (thermoplastic rubber), Style A (straight - installed with carpet), and Style B (coved - installed with resilient flooring), and Style C (butt toe cove installed with 1/8 inch thick flooring). Provide 4 inch high and a minimum 1/8 inch thick wall base. Provide job formed corners in matching height, shape, and color. With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D 5603, fine mesh size particulate, Grade 1, 2, or 3. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Rubber sheet flooring may contain post-consumer or post-industrial recycled content.

2.3 MOULDING

Provide tapered mouldings of rubber or clear anodized aluminum and types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified. Provide vertical lip on moulding of maximum 1/4 inch. Provide bevel change in level between 1/4 and 1/2 inch with a slope no greater than 1:2.

2.4 ADHESIVES

Provide adhesives for flooring, base and accessories as recommended by the manufacturer and comply with local indoor air quality standards. Interior adhesives shall meet the requirements of LEED low emitting materials credit. The current VOC content limits of GS-36 and SCAQMD Rule 1168. Submit manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics. Provide Material Safety Data Sheets (MSDS) for all primers and adhesives to the Contracting Officer. Highlight VOC emissions.

2.5 SURFACE PREPARATION MATERIALS

Provide surface preparation materials, such as panel type underlayment, lining felt, and floor crack fillers as recommended by the flooring

manufacturer for the subfloor conditions. Comply with ASTM F 1482 for panel type underlayment products. Use one of the following substrates:

a. Concrete.

2.6 POLISH/FINISH

Provide polish finish as recommended by the manufacturer and conform to ASTM D 4078 for polish.

2.7 CAULKING AND SEALANTS

Provide caulking and sealants in accordance with Section 07 92 00 JOINT SEALANTS.

2.8 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

Provide color, pattern and texture for resilient flooring and accessories [in accordance with Section 09 06 90 COLOR SCHEDULE [as indicated on the drawings. Color listed is not intended to limit the selection of equal colors from other manufacturers. Provide floor patterns as specified on the drawings Sheet No. I-50. Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern. Submit scaled drawings indicating patterns (including location of patterns and colors) and dimensions. Submit manufacturer's descriptive data and three samples of each indicated color and type of flooring, base, mouldings, and accessories sized a minimum2-1/2 by 4 inch. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 3 EXECUTION

3.1 EXAMINATION

Examine and verify that site conditions are in agreement with the design package. Report all conditions that will prevent a proper installation. Do not take any corrective action without written permission from the Government. Work will proceed only when conditions have been corrected and accepted by the installer. Submit manufacturer's printed installation instructions for all flooring materials and accessories, including preparation of substrate, seaming techniques, and recommended adhesives.

3.2 SURFACE PREPARATION

Provide a smooth, true, level plane for surface preparation of the flooring, except where indicated as sloped. Floor to be flat to within 3/16 inch in 10 feet. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. Prepare the surfaces of lightweight concrete slabs (as defined by the flooring manufacturer. Comply with ASTM F 710 for concrete subfloor preparation. Floor fills or toppings may be required as recommended by the flooring manufacturer. Install underlayments, when required by the flooring manufacturer, in accordance with manufacturer's recommended printed installation instructions. Comply with ASTM F 1482 for panel type underlayments. Before any work under this section is begun, correct all defects such as rough or scaling concrete, chalk and dust, cracks, low spots, high spots, and uneven surfaces. Repair all damaged portions of concrete slabs as recommended by the flooring manufacturer. Remove concrete curing and sealer compounds from the slabs, other than the type that does not adversely affect

adhesion. Remove paint, varnish, oils, release agents, sealers, waxes, and adhesives, as required by the flooring product in accordance with manufacturer's printed installation instructions.

3.3 MOISTURE, ALKALINITY AND BOND TESTS

Determine the suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content and pH level by moisture and alkalinity tests. Conduct moisture testing in accordance with ASTM F 1869 or ASTM F 2170, unless otherwise recommended by the flooring manufacturer. Conduct alkalinity testing as recommended by the flooring manufacturer. Determine the compatibility of the resilient flooring adhesives to the concrete floors by a bond test in accordance with the flooring manufacturer's recommendations. Submit copy of test reports for moisture and alkalinity content of concrete slab, and bond test stating date of test, person conducting the test, and the area tested.

3.4 PLACING VINYL COMPOSITION, LINOLEUM AND SOLID VINYL TILES

Install tile flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's directions. Keep tile lines and joints square, symmetrical, tight, and even. Keep each floor in true, level plane, except where slope is indicated. Vary edge width as necessary to maintain full-size tiles in the field, no edge tile to be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe edge tile to walls and partitions after field flooring has been applied.

3.5 PLACING MOULDING

Provide moulding where flooring termination is higher than the adjacent finished flooring and at transitions between different flooring materials. When required, locate moulding under door centerline. Moulding is not required at doorways where thresholds are provided. Anchor aluminum moulding to floor surfaces as recommended by the manufacturer.

3.6 PLACING WALL BASE

Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Tighten base joints and make even with adjacent resilient flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

3.7 CLEANING

Immediately upon completion of installation of flooring in a room or an area, dry/clean the flooring and adjacent surfaces to remove all surplus adhesive. Clean flooring as recommended in accordance with manufacturer's printed maintenance instructions. No sooner than 5 days after installation, wash flooring with a nonalkaline cleaning solution, rinse thoroughly with clear cold water, and, except for rubber flooring and stair treads, risers and stringers, vinyl and other flooring not requiring polish finish by manufacturer, apply the number of coats of polish in accordance with manufacturer's written instructions. Clean and maintain all other

flooring as recommended by the manufacturer.

3.8 WASTE MANAGEMENT

Separate offcuts and waste materials and reuse or recycle in accordance with the Waste Management Plan, keeping sheet materials larger than 2 square feet and tiles larger than 1/2 tiles separate for reuse. Identify manufacturer's policy for collection or return of construction scrap, unused material, demolition scrap, and/or packaging material. Shred scrap cork and linoleum for composting on site. Place materials defined as hazardous or toxic waste in designated containers and dispose of properly. Close and seal tightly partly used sealant and adhesive containers and store protected in a well ventilated fire-safe area at moderate temperature.

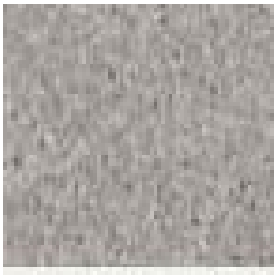
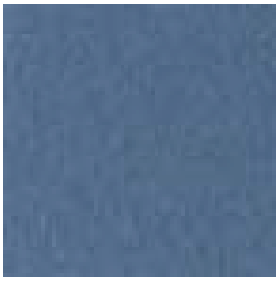
3.9 PROTECTION

From the time of installation until acceptance, protect flooring from damage as recommended by the flooring manufacturer. Remove and replace flooring which becomes damaged, loose, broken, or curled and wall base which is not tight to wall or securely adhered.

-- End of Section --

Appendix B:
Interior Finish Specifications

FORT EUSTIS AIT COMPLEX – PHASE 1 BARRACKS
FORT EUSTIS, VA
INTERIOR FINISH SPECIFICATIONS

RF1 RESILIENT FLOORING TYPE: VCT MFR: ARMSTRONG COMMERCIAL SERIES: IMPERIAL TEXTURE COLOR: 51927 FIELD GRAY SIZE: 12” X 12” X 1/8”	
RF2 RESILIENT FLOORING TYPE: VCT MFR: ARMSTRONG COMMERCIAL SERIES: IMPERIAL TEXTURE COLOR: 51908 PEWTER SIZE: 12” X 12” X 1/8”	
RF3 RESILIENT FLOORING TYPE: VCT MFR: ARMSTRONG COMMERCIAL SERIES: IMPERIAL TEXTURE COLOR: 51882 SERENE BLUE SIZE: 12” X 12” X 1/8”	
B1 RUBBER WALL BASE MFR: BURKE TYPE: COVE RUBBER BASE HEIGHT: 4” COLOR: 208 LIGHT GRAY	

Appendix C:
Armstrong Commercial Installation Guide

Vinyl Composition Tile
Installation System

Product	Adhesive/Full Spread	Adhesive/Tile-On	Comment
Imperial Texture MultiColor RAVE Stonetex Companion Square Feature Tile/Strips	S-89, S-515, S-700 or S-750	S-515 or S-750	Stonetex—lay with directional arrows pointing in the same direction.
ARTEFFECTS	S-89, S-515, S-700 or S-750	S-515 or S-750	For best overall visual effect, install with the directional arrows pointing in the same direction.
SAFETY ZONE	S-89, S-515, S-700, S-750 or S-230	S-515 or S-750	Roll tile with 100-lb. roller. Lay arrows in same direction. For S-230, follow instructions for Specialty Areas.
Vinyl No-Wax (Dry Back)	S-515 or S-750	S-515 or S-750	Roll tile with 100-lb. roller
Urethane No-Wax (Dry Back)	S-89, S-515, S-700 or S-750	S-515 or S-750	Roll tile with 100-lb. roller

Suitable Substrates:

All substrates listed below must be properly prepared and meet the requirements discussed in Chapter IV, Subfloors and Underlayments. There may be certain exceptions and special conditions for these substrates to be suitable for the Vinyl Composition Tile Installation System.

Full Spread:

- Concrete
- Approved Suspended Wood
- Steel, Stainless Steel, Aluminum, Lead, Copper, Brass, Bronze
- Ceramic Tile, Terrazzo, Marble
- Polymeric Poured (seamless) Floors

Tile-On:

- Existing Resilient Sheet Floors
- Vinyl Composition, Vinyl Asbestos, Asphalt, Rubber and Vinyl Tile-on Grade or Suspended Only

Job Conditions/Preparation:

- Substrates must be dry, clean, smooth and free from paint, varnish, wax, oils, solvents and other foreign matter. In renovation or remodel work, remove any existing adhesive residue* so that no ridges or puddles are evident and a thin, smooth film remains.

**Some previously manufactured asphaltic "cutback" adhesives contained asbestos (see warning statement on page xii). For removal instructions, refer to the Resilient Floor Covering Institute's publication Recommended Work Practices for Removal of Resilient Floor Coverings.*

- When using S-230, remove any existing adhesive residue* so that 80% of the overall area of the original substrate is exposed. If these requirements are not followed, curled and/or loose tile could result. For Tile-On, remove wax or other finishes with a commercially available liquid wax stripper. Replace or repair indented or otherwise damaged areas.
- Allow all flooring materials and adhesives to condition to the room temperature a minimum of 48 hours before starting the installation.
- The area to receive resilient flooring should be maintained at a minimum of 65°F (18°C) and a maximum of 100°F (38°C) for 48 hours before, during and for 48 hours after completion. **When using S-230 Epoxy Adhesive the maximum room temperature should not exceed 85°F (29°C).**
- During the service life of the floor the temperature should never fall below 55°F (13°C). The performance of the flooring material and adhesives can be adversely affected below this minimum temperature.
- Conduct calcium chloride tests or percent relative humidity tests. Bond Tests should also be conducted for compatibility with the substrate. Please refer to Chapter IV, Subfloors and Underlayments.
- Radiant-heated substrates must not exceed a maximum surface temperature of 85°F (29°C).
- Concrete floors should be tested for alkalinity. The allowable readings for the installation of Armstrong flooring are 5 to 9 on the pH scale.

Fitting:

See Chapter VII, Layout and Fitting, for room layout.

Before installing the material, plan the layout so tile joints fall at least 6″ (15.2 cm) away from subfloor/underlayment joints. Do not install over expansion joints.

When installing over an existing resilient floor, plan the layout so the new joints are a minimum of 6″ (15.2 cm) away from the original seams. When installing over tile floors, joints should fall in the center of the tile.

When installing 12″ × 12″ (30.5 cm × 30.5 cm) tiles, avoid having border pieces less than 6″ (15.2 cm) wide.

Abutting Different Gauges of Resilient Flooring: When installing thinner gauge material next to thicker gauge materials, install thicker material first and then butt a 12″ (30.5 cm) wide piece of S-153 Scribing Felt against the thicker material. Adhere the Scribing Felt to the subfloor with S-235 Adhesive. Use the fine notching of the Armstrong S-891 Trowel over nonporous substrates such as existing resilient flooring, and use the regular notching of the Armstrong S-891 Trowel over porous subfloors such as wood and concrete. Use Armstrong S-184 Fast-Setting Cement-Based Patch and Skim Coat or S-194 Patch, Underlayment and Embossing Leveler to feather the edge of the S-153 Scribing Felt to the level of the substrate. Allow the patch to dry completely before installing the flooring. Scribing Felt is not recommended to be used under the entire installation.

**Some previously manufactured asphaltic "cutback" adhesives contained asbestos (see warning statement on page xii). For removal instructions, refer to the Resilient Floor Covering Institute's publication Recommended Work Practices for Removal of Resilient Floor Coverings.*

Adhesive Open Times and Working Times

Adhesive	Open Time	Working Time
S-89	60 minutes or more	18 hours
S-515	Approximately 30 minutes or more	24 hours
S-700	Approximately 30 minutes or more	18 hours
S-750	Approximately 30 minutes or more	6 hours
S-230	Minimum 20 minutes	1 hour

NOTE: All adhesives except S-230 should be dry-to-touch before installing tile. The amount of open time will vary according to job conditions, temperature, humidity, air flow and type of substrate. All adhesives are applied with fine notching [1/32″ (0.8 mm) deep, 1/16″ (1.6 mm) wide, 5/64″ (2 mm) apart].

Procedure:

See Chapter VI, Adhesives, Trowel Notchings and Seam Treatments.

When using tile from two or more cartons, check to be sure all pattern and lot numbers are the same to ensure proper color match. On larger installations, open several cartons and mix them as they are installed to help blend any slight shade differences from one carton to the next.

Tile products with directional arrows on the back should be installed with the arrows all pointing in the same direction.

■ Tile Installed Using S-89, S-515, S-700 or S-750:

1. Line off entire area to be installed.
2. Apply the adhesive over the area not covering the chalk lines and using the fine notching of the S-891 Trowel. You may prefer to spread and install one quarter of the room at a time.
3. Allow the adhesive to set until dry-to-touch (except S-230) following the recommended open time. To test, press your thumb lightly on the surface of the adhesive in several places. If the surface feels slightly tacky as your thumb is drawn away and does not stick to your thumb, the adhesive is ready for the installation.
4. Install the tile along the chalk lines, laying the field area first and then fitting in the border tile.
5. Roll all residential tile and SAFETY ZONE in both directions within the adhesive working time using a 100-lb. roller.
6. Clean adhesive from the surface of the tile using a clean white cloth dampened with a neutral detergent and water.
7. Tile should not be exposed to rolling load traffic for at least 72 hours after installation to allow setting and drying of the adhesive.

■ SAFETY ZONE in Specialty Areas:

1. Line off entire area to be installed (Fig. 1).
2 . Move chalk lines to one corner or end of the area farthest from the doorway. These lines should be two or three feet from the wall depending on your reach (Fig. 2).

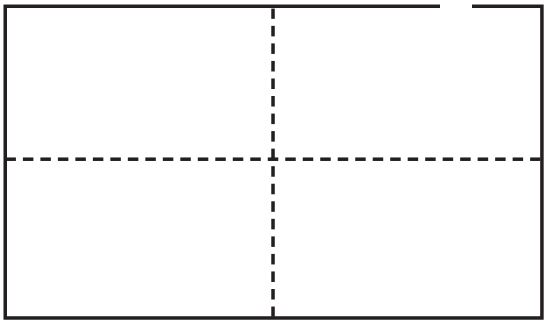


Fig. 1

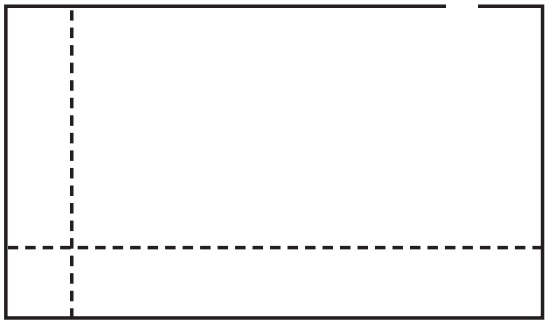


Fig. 2

3. Remove the bottom of S-230 cans Part A and Part B with a can opener. Mix entire contents of Part A and Part B together with a stirring motion while at the same time lifting from the bottom. Mix thoroughly for 3 to 5 minutes to a uniform color. **Do not over mix**. Never mix S-230 Adhesive on the subfloor surface.
4. **Immediately pour the entire unit of mixed adhesive onto the subfloor. Do not leave mixed adhesive in cans because it shortens pot life and working time, and may generate excessive heat.** Maximum pot life of the S-230 Adhesive is approximately 10 minutes depending on temperature and atmospheric conditions.
5. Apply S-230 Adhesive for only two or three rows of tile (Fig. 3). Working time of S-230 is approximately one hour.
6. Tile may be placed into the adhesive immediately, but allowing a 15–20 minute open time and fitting border tile tightly will reduce tile shifting and adhesive oozing. Do not allow the adhesive to dry completely.
7. Install tile with the arrows on the back of the tile pointing in the same direction.

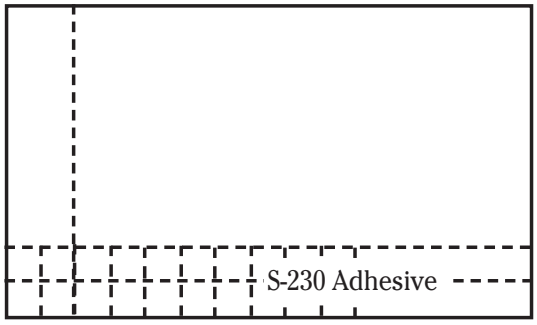


Fig. 3

8. Roll tile in both directions within one hour of spreading S-230 Adhesive using a 100-lb. roller. Re-roll one hour later in both directions. Remove adhesive residue from the surface of all the tile immediately using a clean white cloth dampened with neutral detergent and water. Dried S-230 Adhesive cannot be removed.
9. Do not work on newly adhered tile except to roll tile. Use a kneeling board if necessary.

10. Continue Steps 4 through 9 until entire area is completed.
11. Do not allow traffic on tile for 24 hours after installation.
12. Flooring should not be exposed to rolling load traffic for at least 72 hours after installation to allow setting and drying of the adhesive.

Precautions:

- S-230 Adhesive is recommended for SAFETY ZONE in areas that may be exposed to frequent surface moisture and/or cooler temperatures.
- S-230 Adhesive may also be used to install the first 3 to 5 rows of SAFETY ZONE when used in areas that will be affected by surface moisture and/or cooler temperatures.
- Tiles are to be heated from the back only, never the face.
- Do not wash tile for at least four days after installation. This will allow the tile to become well seated in the adhesive and prevent excess moisture and cleaning agents from interfering with the adhesive bond.
- Products installed using the Tile-On System may have less resistance to indentation. We strongly recommend the use of Armstrong Floor Protectors.
- S-89 is not recommended over wood substrates.

Appendix D:
PACE Roundtable Worksheet