George Mason University - Student Union Building I

Fairfax, Virginia

Brett Robinson

Senior Thesis Presentation 2010

Penn State University

Construction Management

Advisor - James Faust

Presentation Outline

I. Project Overview
II. BIM/IPD – Critical Industry Issue
  I. BIM
  II. IPD
III. In-Depth Safety Plan
  I. Site Specific Safety Rubric
  II. Site Specific Safety Plan
IV. Emergency Power Analysis
  I. Evaluation of Risks
  II. 250kW Kohler Generator Analysis
V. Building Envelope Analysis
  I. Cost/Schedule Analysis
  II. Structural Analysis
VI. Conclusions & Recommendations
VII. Acknowledgments
VIII. Questions & Answers

Overall Theme

Students

- Effects of IPD on Students/User Groups
- Effects of a Site Specific Safety Plan on Students
- Effects of Emergency Power on Student Health and Wellness Center
- Students Views on Building Envelope Systems

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Occupancy Type	Group B (Offices, Classrooms), A-3 (Meeting Rooms larger than 750ft2), A-2 (Restaurant, Dining)
Construction Type	IIA
Size	65,382 GSF
Number of Stories	Four Stories
Dates of Construction	June 2009 - July 2010 (Estimated)
Actual Cost Information	$17.5 million

Project Overview

Project Team

Owner — George Mason University

Design Builder — HESS Construction + Engineering Services

Architects — Grimm + Parker Architects; WTW Architects

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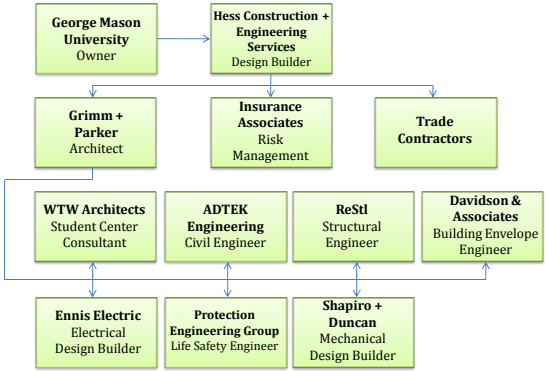
Project Delivery

•Design Build - In Accordance with Commonwealth of Virginia Design Build procedures

Detailed Project Schedule Summary	
Description	**Finish Date**
Notice To Proceed	8/12/09
Site Mobilization/Pre-Construction/ Site Security	9/1/09
Site Excavation & Foundation Work	10/1/09
MEP Below Grade	9/29/09
Structural Frame	12/10/09
Concrete Slab on Grade & Decks	12/10/09
MEP Risers	12/8/09
Exterior Skin	2/9/10
MEP Main Distribution/ Equipment Installation	3/5/10
Roofing	12/14/09
Interior Rough-Ins/Finishes	6/2/10
Building Commissioning	6/30/10
Building Addition Substantial Completion	7/1/10
University FF&E Installation	7/21/10
Occupancy of Addition	7/30/10

Project Overview



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Site

- Central Location
- Very Tight
  - Aquia Creek Lane
  - Occupied Facility (Existing SUB)
  - Construction (Data Center)
  - Student Housing

Project Overview

Site

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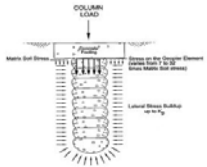
Project Overview

Building Systems - Structural



Foundation
- (143) 30" Dia., 25' Deep Geopiers
- 12" Lifts of Aggregate

Framing
- ASTM A992/A992M–06a Wide Flange Beams and Columns
- ASTM A108–07 Stud–Type Shear Connectors
- 3.5" 4,000 psi lightweight concrete over a 2" 18 gauge composite steel deck

Project Overview

Building Systems – Electrical

Total Load for Existing and New Student Union Buildings – 1384.5 KVA, includes:
- Existing Building Highest Demand Load – 528 KVA
- New Motor Load – 421.8 KVA
- New Receptacle Load – 235.5 KVA
- New Lighting Load – 89.8 KVA

250 kW Kohler Diesel Generator

HURD & OBENCHAIN, INC. CONSULTING ENGINEERS

EMILE ELECTRIC CO., INC. MANASSAS, VA

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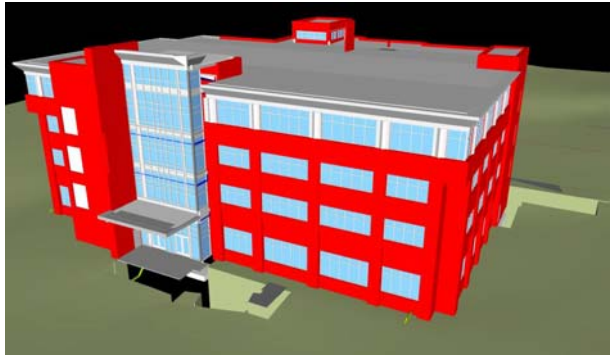
BIM/IPD

Building Information Modeling

Project utilized BIM from beginning of the Design Development Stage

Strictly used for:

- 3D Coordination
- 4D Sequencing



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Integrated Project Delivery

Project Delivery Method

- Integrates people, systems, business structures and practices into a process
- Harnesses the talents and insights of all participants

BIM/IPD

Fundamental Principles of IPD

- Mutual Respect & Trust
- Mutual Benefit & Reward
- Collaborative Innovation & Decision Making
- Early Involvement of Key Participants
- Early Goal Definition
- Intensified Planning
- Open Communication
- Appropriate Technology
- Organization & Leadership

BIM/IPD

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Keys to Building an IPD Team

1. Identify the participant roles for the project, at the earliest possible time.
2. Pre-qualify members of the team.
3. Seek involvement from building officials, local utility companies, insurers, sureties, and other stakeholders.
4. Define the values, goals, interests and objectives.
5. Identify the organizational structure consistent with the participants' needs and constraints.
6. Develop project agreements that define the roles and accountability of the participants.

IPD vs. Design Build

- Characterized by a single point of responsibility for both design and construction
  - Requires heavy involvement early by the owner to defining the project criteria
  - Decreased involvement follows as the project progresses
- Chosen by owners to:
  - Reduce project-based risk
  - Transfer coordination effort to one contractual entity

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Benefits of IPD

Owners

•Effectively balance project options to meet goals
  •Schedule
  •Life cycle costs
  •Quality

Contractors

•Contributes expertise during design process
•Improves project quality and financial performance during the construction phase
•More timely and informed understanding of the design
•Visualize Construction Sequence

IPD

Benefits of IPD

Student Fiscal Services	# Employee	SF/ Room	# Rooms	Room NFS Total	Floor	Wall	Ceiling
Director	1	180	1	180	Carpet Type 2	Gypsum Board Painted Eggshell Finish	Acoustic Ceiling Tile
Associate Director	2	144	2	288	Carpet Type 2	Gypsum Board Painted Eggshell Finish	Acoustic Ceiling Tile
Assistant Director	1	120	1	120	Carpet Type 2	Gypsum Board Painted Eggshell Finish	Acoustic Ceiling Tile
Full-time Professional(s) (includes 2 future)	6	120	6	720	Carpet Type 2	Gypsum Board Painted Eggshell Finish	Acoustic Ceiling Tile
Technical Staff (includes 1 future)	2	120	2	240	Carpet Type 2	Gypsum Board Painted Eggshell Finish	Acoustic Ceiling Tile
File Storage (includes 1 future room)	1	400	1	400	Vinyl Composition Tile	Gypsum Board Painted Eggshell Finish	Acoustic Ceiling Tile
Student Workers (includes 1 future)	2	48	1	48	Carpet Type 2	Gypsum Board Painted Eggshell Finish	Acoustic Ceiling Tile

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In-Depth Safety Plan

In-Depth Safety Plan Goals

- Reasons for In-Depth Safety Plan
- Advantages
- Site Specific Safety Rubric
- Site Specific Safety Plan

In-Depth Safety Plan

Reasons for In-Depth Safety Plan

- To verify hazards have been mitigated by safety policies and procedures
- To maintain compliance with OSHA requirements

In-Depth Safety Plan Advantages

- Administrative organization and preparation complying with project requirements
- Reduces work related injuries and illnesses
- Improves employee morale and productivity
- Reduces workers' compensation costs

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In-Depth Safety Plan Rubric

Effective occupational safety and health programs will include:

- •Management commitment and employee involvement
- •Worksite analysis
- •Hazard prevention and control
- •Safety and health training

The purpose of this submission is to ensure the safety of the general public, students, and staff.

In-Depth Safety Plan

In-Depth Safety Plan Rubric

- •Section 8 - Visitors
- •Section 24 - General and Hess Specific Safety Requirements
  - •General Work Rules
  - •Electrical
- •Section 25 – Job Hazard Analysis
- •Section 29 - General Public Protection and Environment Health
- •Section 32 – Site Specific Safety Considerations
  - •Work Control Measures
  - •Site Configuration
  - •Occupied Renovations
  - •Pedestrian Safety

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In-Depth Safety Plan

Section 25 – Job Hazard Analysis

Supervisors will complete a Job Hazard Analysis (JHA) for activities with input from the associate(s) that will be assigned to perform the activities. The JHAs must be reviewed with the associate(s) as appropriate to assist with safety training and planning of the activities to include proper selection and use of personal protective equipment (PPE).

In-Depth Safety Plan

In-Depth Safety Plan

In accordance with OSHA 3071 JHA processes will include:

- Description of work phase or activity
- Identification of all potential hazards
- List mitigation procedures
- Identification of specialized training required
- Identification of special permits required
- Name and contact information of the trade contractor's competent persons

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In-Depth Safety Plan

Section 32 – Site Specific Safety Considerations
Site Configuration

Due to the tight configuration of the site, space will be at premium. Coordination (and cooperation) between trades and their operations will be vital to the success of the project. The "tightness" of the site shall be discussed as a component of all pre-construction meetings with trade contractors so that this element is a planned component of their operations. HESS will conduct weekly foreman's meetings which shall address upcoming operations and the coordination of trades and their operations.

In-Depth Safety Plan

In-Depth Safety Plan

•10 ft clearance from buildings or structures shall be kept clear from accumulation of rubbish and material
•Interaction between dangerous/harmful facilities and sensitive facilities will be considered
  •Can be noisy or even emit harmful substances
  •Should be kept a far distance away from sensitive facilities
    •Offices
    •Student housing

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Emergency Power Analysis Goals

- Standards and Codes
- Evaluate Risks
  - Generator Availability
  - Critical Areas
- Current Emergency Generator Analysis
  - Connected Load Analysis
  - Routine Maintenance and Operational Testing

Emergency Generator Analysis

Standards and Codes

- NFPA-110 (Emergency and Standby Power Systems)
  - Should be installed in a location that permits ready accessibility
  - Power must be able to come online within:
    - 10 seconds for critical applications
    - 30 seconds for non-critical applications
  - Routine maintenance and operational testing

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Emergency Generator Analysis

Evaluation of Risks

How quickly must the emergency power come on?

- Generator starts instantly
- Transfer of power10 seconds (NFPA 110)

How long should the emergency power be available for?

- Stay online until it senses that the power is back on

Emergency Generator Analysis

Evaluation of Risks

How crucial is it to maintain operation during power outages?

- Majority of the SUB I project - non-critical element
- Student Health and Wellness Center -critical

What locations within the facility will be powered by the emergency power?

- Health and Wellness Center (Receptacles and Emergency Lights)
- Food Court (Refrigerator/Freezing Units)
- Corridors/Atrium (Emergency Lights)
- Elevator

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Emergency Generator Analysis

Evaluation of Risks

Health and Wellness Center

- Sixteen Exam Room
- Nurse's Station
- Immunization Room
- Short Term Stay Room
- Pharmacy
- Lab

GEORGE MASON UNIVERSITY | Student Health Services

Emergency Generator Analysis

Pharmaceuticals Expiration within 48 Hours

Drug	Manufacturer	Normal Stage	Max time at >8 C	Comments	Reference
BCG-S medac inj	TechnoPharm	2-8 °C	24 hours	Valid for temperatures between 15-19.9 °C. Return to fridge. Effect on shelf life unknown.	Company
Eprex (with polysorbate)	Janssen-Cilag	2-8 °C	48 hours	Vials/syringes containing polysorbate 80. Valid for temperatures up to 25 °C. Return to fridge.	Company
Esmeron inj	Organon Teknika	2-8 °C	see comment	If left out of the fridge for more than 24 hours, store between 8-30 °C (do not return to fridge) and mark with 3 month expiry date.	SPC & Company
Oxbipp paste	Oxford	2-8 °C	24 hours	Return to fridge. Original expiry valid	Company
Oxbipp-g gauze	Oxford	2-8 °C	48 hours	Return to fridge. Original expiry valid	Company
Pancrex products	Yamanouchi	2-8 °C	see comment	Previously storage conditions were <15 °C. Company recommend discarding if out of fridge more than 2-3 hours	Company

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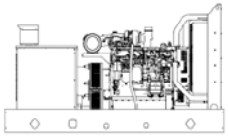
Emergency Generator Analysis

Kohler Diesel 250kW 250REOZJD Generator



250REOZJD General Specifications	
Prime Ratings Range kW	225-230
Prime Ratings Range kVA	281-288
Standby Ratings Range kW	250-255
Standby Ratings Range kVA	313-319
Hertz	60 Hz
EPA Tier Level	3
Dimensions (LxWxH)	193"x54"x132"
Dry Weight	10,000 lbs
Max Power at Rated RPM	287 kWm (385 BHP)
Horsepower	385
Fuel Tank	966 Gallon Sub-Base

Emergency Generator Analysis

Connected Electrical Loads

- Fire Pump – 58.2 kVA
- Elevator – 10 kVA
- Receptacle – 87.07 kVA
- Emergency Lighting (New) – 20.63 kVA
- Emergency Lighting (Existing) – 6.91 kVA
- Refrigerator/Freezing Units – 23.95 kVA
- Misc. Security/Fire Alarm – 12.7 kVA

Total Calculated kVA – 219.47 kVA

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Routine Maintenance and Operational Testing

Load Bank Test
- •Required by NFPA 110
- •Simulates the full electrical demands
- •One hour

Weekly Checks
- •Fuel Check
- •Oil Check
- •Exhaust Check
- •Cooling System Check

Emergency Generator Analysis

Routine Maintenance and Operational Testing

Monthly Testing
- •Simulates the full electrical demands
- •30 to 40 minutes

Testing Documentation
- •Date of the report
- •Name(s) of the person(s) providing the service
- •Identification of unsatisfactory conditions
- •Corrective action taken (including parts replaced)
- •Testing of repairs recommended by the manufacturer

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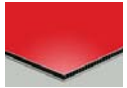
Building Envelope Analysis Goals

- Research Building Envelope Systems
  - Metal-Faced Composite Panels
  - Pre-Cast Architectural Panels
  - Aluminum Storefront System
- Students' Opinion of Various Building Envelope Systems
- Cost Analysis
- Schedule Analysis
- Structural Analysis

Building Envelope Analysis

Building Envelope Overview

Metal-Faced Composite Panels



Pre-Cast Architectural Panels

Aluminum Storefront System

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Building Envelope Analysis

Penn State HUB Student Survey

Which Building front is more visibly pleasing to you?

Aluminum Storefront (Existing)	39	78%
Architectural Pre-cast Concrete Panels	7	14%
Metal Panels	4	8%

George Mason University - Student Union Building I
Fairfax, Virginia

Building Envelope Analysis

Penn State HUB Student Survey

How important is the natural day lighting for you?

Very Important	20	40%
Important	24	48%
Average	5	10%

Are you satisfied with the natural day lighting inside the HUB?

Yes	45	90%
No	3	6%
Undecided	2	4%

April 12, 2010

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Cost Analysis

Company	Cost per Sq. Ft.	Description	Total Cost	Additional Cost
CVT Construction	$24.00	Laminators Incorporated Omega Lite Metal Panel	$41,546.49	NA
Nitterhouse	$30.00 to $35.00	7" Architectural Wall Panel	$60,588.64	$19,042.14
CVT Construction	$33.00	Storefront system, Aluminum Frame, Clear 3/8" Plate Glass, To 12' High, Institutional Grade	$57,126.43	$15,579.94

Building Envelope Analysis

Schedule Analysis

Company	Rate of Work	Description	Total Days
CVT Construction	300 Sq. Ft. per day	NA	6
Phoenix Erectors	30 Lifts	P & H Truck Crane	3
CVT Construction	350 Sq. Ft. per day	NA	5

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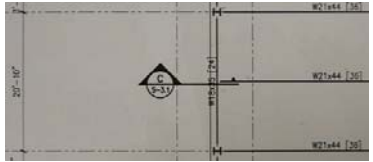
Structural Analysis - Beam C4-C5 (W18x35)

Point Load (W21x44)

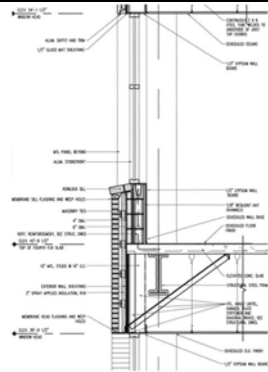
- Lightweight Concrete – 44 psf
- Deck – 3 psf
- Live Load - 80psf +20psf (partitions)
- Superimposed Dead Load - 15 psf
- Beam Weight - 810.33 lbs



Structural Analysis - Beam C4-C5 (W18x35)

Distributed Load from Exterior

- Medium Weight 8" CMU – 55 psf
- 4" Brick – 42 psf
- Storefront– 12 psf
- Metal Panel – 1.1 psf
- Architectural Pre-cast – 35 psf



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III. In-Depth Safety Plan
  I. Site Specific Safety Rubric
  II. Site Specific Safety Plan
IV. Emergency Power Analysis
  I. Evaluation of Risks
  II. 250kW Kohler Generator Analysis
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Structural Analysis - Beam C4-C5 (W18x35)

Moment - ΦM_n = 515 kft

- Metal Panel - M_{max} = 513.23 kft (OK)
- Architectural Precast - M_{max} = 517.62 kft (Increase Beam Size)
- Storefront - M_{max} = 514.64 kft (OK)

Building Envelope Analysis

Structural Analysis - Beam C4-C5 (W18x35)

Deflection - Δ_{max} = 0.694”

- Metal Panel - Δ = 0.426” (OK)
- Architectural Precast - Δ = 0.434” (OK)
- Storefront - Δ = 0.428” (OK)

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Recommendations

- **BIM/IPD – Critical Industry Issue**
  - IPD – Viable Project Delivery Method for GMU
- **In-Depth Safety Plan**
  - Set Specific Deliverables
- **Emergency Power Analysis**
  - Work in collaboration with GMU and different user groups on Contingency Plan
- **Building Envelope Analysis**
  - Continuation of Storefront
    - Addition of $15,579.94
    - Deduction of 1 day of installation

Conclusions

My Opinion and Experiences

- Networking with High Profile IPD and BIM Personnel
- Earned true appreciation for Emergency Power and inspection process

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Brett Robinson - Construction Management

Questions

George Mason University - Student Union Building I
Fairfax, Virginia

Questions and Answers

April 12, 2010