BSC	Design Calculation or Analysis Cover Sheet	1. QA: QA 2. Page 1
	Complete only applicable items.	

3. System Receipt Facility (RF)	4. Document Identifier 200-SYC-RF00-00100-000-00A
5. Title Receipt Facility (RF) Mass Properties	ENG.20061206.0001
6. Group Civil/Structural/Architectural	
7. Document Status Designation ☐ Preliminary ☒ Committed ☐ Confirmed ☐ Cancelled/Superseded	
8. Notes/Comments	

Attachments	Total Number of Pages
Attachment A	8

RECORD OF REVISIONS

9. No.	10. Reason For Revision	11. Total # of Pgs.	12. Last Pg. #	13. Originator (Print/Sign/Date)	14. Checker (Print/Sign/Date)	15. Approved/Accepted (Print/Sign/Date)
00A	Initial Issue	36	36	S. Kothari [signature] 11/29/2006	A. Joshi [signature] 11/29/2006	R. Rajagopal [signature] 12/6/06 JA 11/29/06

DISCLAIMER

The calculations contained in this document were developed by Bechtel SAIC Company, LLC (BSC) and are intended solely for the use of BSC in its work for the Yucca Mountain Project.

CONTENTS

1. PURPOSE

The purpose of this calculation is to compute the mass properties of the Receipt Facility (RF) concrete shear wall structure. The computed mass properties will then be used in the development of a "beam / column" lumped mass stick model for the Tier 1 seismic analysis of the RF structure. The basis of design for the RF is defined in the 000-3DR-MGR0-00300-000, *Basis of Design for the TAD Canister-Based Repository Design Concept* (Ref. 2.1.4).

2. REFERENCES

2.1 DESIGN INPUTS

2.1.1 BSC (Bechtel SAIC Company) 2006. *Project Design Criteria Document.* 000-3DR-MGR0-00100-000 REV 006. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061201.0005.

2.1.2 Clough, R.W. and Penzien, J. 1975. *Dynamics of Structures.* New York, New York: McGraw-Hill. TIC: 254783. [DIRS 164683]

2.1.3 BSC (Bechtel SAIC Company) 2004. *Seismic Analysis and Design Approach Document.* 100-S0C-CY00-00300-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040405.0017; ENG.20050823.0019.

2.1.4 BSC (Bechtel SAIC Company) 2006. *Basis of Design for the TAD Canister-Based Repository Design Concept.* 000-3DR-MGR0-00300-000-000. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061023.0002.

2.1.5 BSC (Bechtel SAIC Company) 2006. *Receipt Facility Preliminary Layout Ground Floor Plan.* 200-P0K-MGR0-10301-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061003.0002.

2.1.6 BSC (Bechtel SAIC Company) 2006. *Receipt Facility Preliminary Layout Second Floor Plan.* 200-P0K-MGR0-10401-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061003.0003.

2.1.7 BSC (Bechtel SAIC Company) 2006. *Receipt Facility Preliminary Layout Third Floor Plan.* 200-P0K-MGR0-10501-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061003.0004.

2.1.8 BSC (Bechtel SAIC Company) 2006. *Receipt Facility Preliminary Layout Section A.* 200-P0K-MGR0-10601-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061003.0005.

2.1.9 BSC (Bechtel SAIC Company) 2006. *Receipt Facility Preliminary Layout Section B.* 200-P0K-MGR0-10701-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061003.0006.

2.2 DESIGN CONSTRAINTS

2.2.1 EG-PRO-3DP-G04B-00037, Rev. 006, ICN 0. *Calculations and Analyses*. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061204.0001.

2.2.2 IT-PRO-0011, Rev. 002, ICN 0. *Software Management*. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.2001109.0011.

2.2.3 BSC (Bechtel SAIC Company) 2006. *Quality Management Directive.* QA-DIR-10, Rev. 0. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20060906.0001. [DIRS 177655]

2.2.4 ORD (Office of Repository Development) 2006. *Repository Project Management Automation Plan.* 000-PLN-MGR0-00200-000, Rev. 00D. Las Vegas, Nevada: U.S. Department of Energy, Office of Repository Development. ACC: ENG.20060703.0001.

2.3 DESIGN OUTPUTS

2.3.1 BSC (Bechtel SAIC Company) 2006. *Receipt Facility: Soil Springs and Damping.* 200-SYC-RF00-00300-000-00A. Las Vegas, Nevada: Bechtel SAIC Company.

2.3.2 BSC (Bechtel SAIC Company) 2006. *RF Seismic Analysis.* 200-SYC-RF00-00400-000-00A. Las Vegas, Nevada: Bechtel SAIC Company.

3. ASSUMPTIONS

3.1 ASSUMPTIONS REQUIRING VERIFICATION

3.1.1 The RF Structure's plan dimensions, elevations, wall/slab thicknesses and other data are taken from plans and sections shown in Attachment A and will be used as the basis for computation of the mass properties.

Rationale: Attachment A was developed using the current Plant Design sketches (Ref. 2.1.5 thru 2.1.9). The Plant Design sketches represent the latest available layout configuration of the facility.

3.1.2 Structural steel framing loads are assumed as follows.

Roofs at 32', 64', 72' and 100', Floor at 32'– 40 lbs/ft^2

Base slab at 0' – 10 lbs/ft^2

Rationale: Structural steel represents a small fraction of the total mass of the RF structure. Actual steel weights will be used as the design matures in the detailed design phase of the project.

3.1.3 Equipment dead loads are assumed as 100 lbs/ft^2 on the floor slabs and 10 lbs/ft^2 on the roof slabs, respectively. Equipment dead loads include cranes less than 50 Tons capacity, HVAC equipment, Electrical equipment and so forth. The following cranes are greater than 50 Tons capacity: 75 Tons Canister Transfer Machine and 200 Tons crane in Prep Area. A crane weight include the load blocks, trolley and bridge and is shown in spreadsheet on page 12. Horizontal force due to crane lifted loads are excluded due to the pendulum effects of a suspended load.

Rationale: The RF is not an equipment intensive structure with the major equipment being the material handling cranes and HVAC equipment. 100 lbs/ft^2 is a reasonable assumption for this type of structure. The assumed crane loads for cranes more than 50 Tons capacity is based on preliminary design information provided by the Mechanical Handling Group. Actual equipment weights will be used as the design matures in the detailed design phase of the project.

3.1.4 Roofing material dead load is assumed as 55 lbs/ft^2.

Rationale: This is a reasonable assumption that allows for a lightweight concrete fill material (approx. 114 lb/ft^3) to be applied over the concrete slab with an average thickness of 6 inches including waterproof membrane for the roofing material.

3.1.5 Live load is assumed as 100 lbs/ft^2 for floor live load and 40 lbs/ft^2 for roof live load. 25 percent (25 lbs/ft^2 and 10 lbs/ft^2) of these loads will be included for calculating the mass properties for use in the seismic analysis.

Rationale: 100 lbs/ft^2 live load for floor live load and 40 lbs/ft^2 live load for roof is the standard engineering practice for heavy industrial buildings. Consideration of 25% of live load during seismic event is consistent with 100-SOC-CY00-00300-000, *Seismic Analysis and Design Approach Document* (Ref. 2.1.3, Section 7.2.2.1).

3.2 ASSUMPTIONS NOT REQUIRING VERIFICATION

3.2.1 Wall openings were not considered in the mass calculation.

Rationale: Major wall openings have a shield door, which is approximately equal to the weight of concrete removed to form the opening. Neglecting other door openings is conservative since a larger mass will result in a larger load to be carried by the walls.

3.2.2 The mass of any moving crane weighing more than 50 Tons is assumed as concentrated mass acting at location giving maximum eccentricity.

Rationale: Using concentrated mass instead of uniformly distributed mass is conservative. Considering mass acting at location giving maximum eccentricity is bounding.

4. METHODOLOGY

4.1 QUALITY ASSURANCE

This calculation was prepared in accordance with EG-PRO-3DP-G04B-00037, *Calculations and Analyses* (Ref. 2.2.1). Section 6.1.2 of the *Basis of Design for the TAD Canister-Based Repository Design Concept* (Ref.2.1.4) classifies the RF structure as ITS. Therefore, this document is subject to the requirements of the BSC *Quality Management Directive* (Ref. 2.2.3, Section 2.1.C.1.1.a.i. and 17.E.) and the approved version is designated as QA: QA.

4.2 USE OF SOFTWARE

Excel 97 and Word 97, which are part of the Microsoft Office 97 suite of programs, were used in this calculation. Excel 97 and Word 97 as used in this calculation are considered a Level 2 software usage and are not required to be qualified under the procedure of *Software Management* [Ref. 2.2.2, Section 1.2]. Microsoft Office 97 Professional is listed on the current Software Report (SW Tracking Number 602338), as well as the *Repository Project Management Automation Plan* (Ref. 2.2.4).

The software is operated on a PC system running the Microsoft Windows 2000 operating system.

The calculation process and equations are documented in Section 6 of this document for checking by manual calculation.

4.3 DESCRIPTION OF CALCULATION APPROACH

Attachment A was developed by using plant design sketches (Reference 2.1.5 to 2.1.9) except concrete buttress wall and basemat under the wall at ground floor and buttress walls above elevation 64’ are not considered in this calculation. Plans with wall/slab thickness and dimensions shown in Attachment A will be used as the basis for computation of the mass properties of the RF (Assumption 3.1.1).

The masses of the structure are lumped at the diaphragm (floor/roof) elevation of the structure. For the RF, the diaphragm elevations are located at elevation 0’, 32’, 64’, 72’ and 100’. See Attachment A. Masses of the walls are lumped at the diaphragm by considering half of the wall mass is tributary to the floor/roof at the bottom of the wall and half of the mass is tributary to the floor/roof at the top of the wall. Elevation 16’, 48’, 68’ and 82’ are centerline of wall height between floors.

5. LIST OF ATTACHMENTS

	Number of Pages
Attachment A: Receipt Facility (RF) Plans and Sections	8

6. BODY OF CALCULATIONS

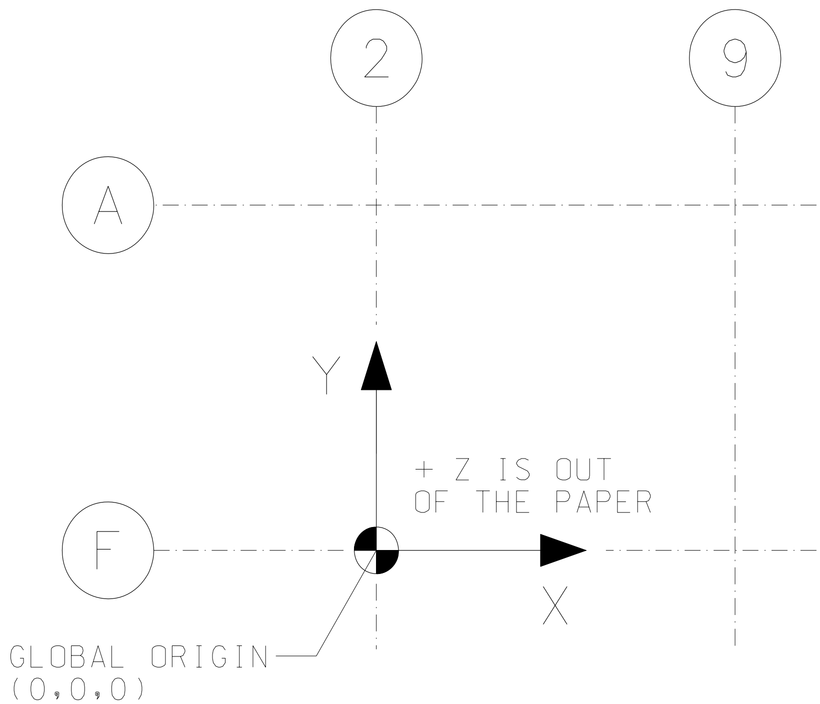
In this section of the calculation, the mass, center of mass and mass moments of inertia of the structure are computed for the various diaphragm (floor/roof) elevations using basic principles of mechanics of materials.

The following spreadsheets, pages 9 to 27, are used to compute the mass, center of mass and mass moments of inertia for slabs and walls for each diaphragm elevation. Results from the slab and wall spreadsheets were used in summary spreadsheet to compute the overall mass and center of gravity for the combination of the slabs and walls at a given diaphragm elevation.

Concrete density is 150 pcf (Ref. 2.1.1, Section 4.2.11.6.6).
Acceleration due to gravity, g =32.2 ft/Sec^2 used on pages 21 through 26.

Assumption 3.1.1 is used on pages 9 to 18. Assumptions 3.1.2, 3.1.3 and 3.1.4 are used on pages 9 to 14. Assumption 3.1.5 is used on pages 11 to 14. Assumption 3.2.1 refers to attachment A, page 30 to 36. Assumption 3.2.2 is used on pages 12, 19 and 23.

The Cartesian coordinate origin (0,0,0) for the RF, located at the intersection of column lines 2 and F, at elevation 0'-0" is used in computing the center of mass and mass moments of inertia as shown below. The positive X-axis extends from the origin toward column line 9 along column line F. The positive Y-axis extends from the origin toward column line A along column line 2. The positive Z-axis extends vertically upward from the origin.



Floor Elevation 0' (See attachment A, page 30)

Slab (**2) (see note)	Width (W) (Xdim) (ft)	Length (L) (Ydim) (ft)	Thickness t (ft)	(**3) Weight L*W*t*.15 Wt (kips)	CG Xi (**1) (ft)	CG Yi (**1) (ft)	Wt * CG Xi (ft-kips)	Wt * CG Yi (ft-kips)	Structural Steel Load (10 psf) W1 (kips)	Floor Equipment Dead Load (100 psf) W2 (kips)	Floor Live Load (25psf) W3 (kips)	(**4) Wi * CG Xi (ft-kips)	(**4) Wi * CG Yi (ft-kips)	Total Weight W_{total} (kips)	W_{total} *CG Xi (ft-kips)	W_{total} * CGYi (ft-kips)
C-E/2-3	42	78	4	1965.6	20	119	39312.0	233906.4	32.8	327.6	81.9	8845.2	52628.9	2407.9	48157.2	286535.3
A-F/3-8	200	242	7	50820.0	141	119	7165620.0	6047580.0	484.0	4840.0	1210	921294.0	777546.0	57354.0	8086914.0	6825126.0
C-E/8-9	42	78	4	1965.6	262	119	514987.2	233906.4	32.8	327.6	81.9	115872.1	52628.9	2407.9	630859.3	286535.3
			Σ =	**54751.2**			**7719919.2**	**6515392.8**	**549.5**	**5495.2**	**1373.8**	**1046011.3**	**882803.9**	**62169.7**	**8765930.5**	**7398196.7**

	xbar	ybar		
Center of Mass of Concrete =	**141.0**	**119.0**	**xbar = Σ (Wt * CGXi)/Σ Wt**	**ybar = Σ (Wt * CGYi)/Σ Wt**
Center of Applied Mass =	**141.0**	**119.0**	**xbar = Σ (Wi * CGXi)/Σ Wi**	**ybar = Σ (Wi * CGYi)/Σ Wi**
Centroid of All Masses =	**141.0**	**119.0**	**xbar = Σ (W_{total} * CGXi)/Σ W_{total}**	**ybar = Σ (Wtotal * CGYi)/Σ Wtotal**

**1 For coordinate system definition see page 8.

**2 Numbers and letters are in reference to the column grid lines for the building (See attachment A).

**3 Concrete wall/slab weights are computed based on a concrete unit weight of 150 lbs/ft^3 (Ref. 2.1.1, Section 4.2.2.6.6).

**4 Σ Wi = Σ(W1+W2+W3)

Floor Elevation 32' (See attachment A, page 31)

Slab (**2)	Width (Xdim) (ft)	Length (Ydim) (ft)	Thickness (ft)	Weight (see below) Wt (kips)	CG Xi (**1) (ft)	CG Yi (**1) (ft)	Wt * CG Xi (ft-kips)	Wt * CG Yi (ft-kips)	Structural Steel Load (40psf) W1 (kips)	Floor Equipment Dead Load (100psf) W2 (kips)	Floor Live Load (25psf) W3 (kips)	(**4) Wi * CGXi (ft-kips)	(**4) Wi * CGZi (ft-kips)	Total Weight W_{total} (kips)	W_{total} * CGXi (ft-kips)	W_{total} * CGYi (ft-kips)
A-B/3-4	42	35	1.5	363.1	66	218.5	23963.9	79335.2	58.8	147.0	36.8	16008.3	52997.2	605.6	39972.2	132332.3
A-C/4-8	146	78	1.5	2812.8	164	197	461305.1	554128.7	455.5	1138.8	284.7	308159.3	370166.9	4691.9	769464.4	924295.6
C-E/2-3	40	74	1.5	731.1	21	119	15353.5	87003.3	118.4	296.0	74.0	10256.4	58119.6	1219.5	25609.9	145122.9
C-E/3-6	101	70	4	4397.5	95.5	119	419965.1	523307.3	282.8	707.0	176.8	111405.5	138819.5	5564.1	531370.6	662126.7
E-F/3-8	192	78	1.5	3699.1	141	41	521569.2	151662.0	599.0	1497.6	374.4	348416.6	101312.6	6170.1	869985.8	252974.6
			Σ =	**12003.7**			**1442156.8**	**1395436.3**	**1514.6**	**3786.4**	**946.6**	**794246.1**	**721415.8**	**18251.2**	**2236402.9**	**2116852.2**

	xbar	ybar		
Center of Mass of Concrete =	**120.1**	**116.3**	**xbar = Σ (Wt * CGXi)/Σ Wt**	**ybar = Σ (Wt * CGYi)/Σ Wt**
Center of Applied Mass =	**127.1**	**115.5**	**xbar = Σ (Wi * CGXi)/Σ Wi**	**ybar = Σ (Wi * CGYi)/Σ Wi**
Centroid of All Masses =	**122.5**	**116.0**	**xbar = Σ (W_{total} * CGXi)/Σ W_{total}**	**ybar = Σ (W_{total} * CGYi)/Σ W_{total}**

**1 For coordinate system definition see page 8.
**2 Numbers and letters are in reference to the column grid lines for the building.
**3 Slab dimensions are all inside face of walls.
**4 Σ Wi = Σ(W1+W2+W3)
Weight Computation: Slab weights are computed as follows Weight = (Length*Width*Thickness*((thickness*.15+.022)/thickness)
the ((thickness*.15+.022)/thickness) term computes a weighted density that accounts for the weight of concrete in the metal decking valley of a three inch metal deck which weighs approximately 22 psf.

Elevation 32' (Lower Roof) (See attachment A, page 31)

Slab (**2)	Width (Xdim) (ft)	Length (Ydim) (ft)	Thickness (ft)	Weight (see below) Wt (kips)	CG Xi (**1) (ft)	CG Yi (**1) (ft)	Wt * CG Xi (ft-kips)	Wt * CG Yi (ft-kips)	Structural Steel Load (40 psf) W1 (kips)	Floor Equipment Dead Load (100 psf) W2 (kips)	Roof Live Load (10 psf) W3 (kips)	Roofing Load (55 psf) W4 (kips)	Roof Equipment Dead Load (10 psf) W5 (kips)	(**4) Wi * CGXi (ft-kips)	(**4) Wi * CGYi (ft-kips)	Total Weight W_{total} (kips)	W_{total} * CGXi (ft-kips)	Wtotal * CGYi (ft-kips)
C-E/8-9	40	74	1.5	731.1	261	119	190822.3	87003.3	118.4	0.0	29.6	162.8	29.6	88844.4	40507.6	1071.5	279666.7	127510.9
			Σ =	**731.1**			**190822.3**	**87003.3**	**118.4**	**0.0**	**29.6**	**162.8**	**29.6**	**88844.4**	**40507.6**	**1071.5**	**279666.7**	**127510.9**

	xbar	ybar		
Center of Mass of Concrete =	**261.0**	**119.0**	**xbar = Σ (Wt * CGXi)/Σ Wt**	**ybar = Σ (Wt * CGYi)/Σ Wt**
Center of Applied Mass =	**261.0**	**119.0**	**xbar = Σ (Wi * CGXi)/Σ Wi**	**ybar = Σ (Wi * CGYi)/Σ Wi**
Centroid of All Masses =	**261.0**	**119.0**	**xbar = Σ (W_{total} * CGXi)/Σ W_{total}**	**ybar = Σ (W_{total} * CGYi)/Σ W_{total}**

**1 For coordinate system definition see page 8.
**2 Numbers and letters are in reference to the column grid lines for the building.
**3 Slab dimensions are all inside face of walls.
**4 Σ Wi = Σ(W1+W2+W3+W4+W5)
Weight Computation: Slab weights are computed as follows Weight = (Length*Width*Thickness*((thickness*.15+.022)/thickness)
the ((thickness*.15+.022)/thickness) term computes a weighted density that accounts for the weight of concrete in the metal decking valley of a three inch metal deck which weighs approximately 22 psf.

Elevation 64' (Middle Roof) (See attachment A, page 32)

Slab (**2)	Width (Xdim) (ft)	Length (Ydim) (ft)	Thickness (ft)	Weight (see below) Wt (kips)	CG Xi (**1) (ft)	CG Yi (**1) (ft)	Wt * CG Xi (ft-kips)	Wt * CG Yi (ft-kips)	Structural Steel Load (40 psf) W1 (kips)	Crane Dead Load W2 (kips)	Roof Live Load (10 psf) W3 (kips)	Roofing Load (55 psf) W4 (kips)	Roof Equipment Dead Load (10 psf) W5 (kips)	(**4) Wi * CGXi (ft-kips)	(**4) Wi * CGYi (ft-kips)	Total Weight W_{total} (kips)	W_{total} * CGXi (ft-kips)	Wtotal * CGYi (ft-kips)
A-C/3-8	192	78	1.5	3699.1	141	197	521569.2	728717.2	599.0		149.8	823.7	149.8	242835.8	339281.3	5421.3	764405.0	1067998.5
E-F/3-8	192	78	1.5	3699.1	141	41	521569.2	151662.0	599.0		149.8	823.7	149.8	242835.8	70611.8	5421.3	764405.0	222273.8
C-E/2-3	40	74	1.5	731.1	21	119	15353.5	87003.3	118.4		29.6	162.8	29.6	7148.4	40507.6	1071.5	22501.9	127510.9
Crane 200T in Prep Area **5					223.5	142.5				300.0						300.0	67050.0	42750.0
Canister Transfer Machine** 5					127	142				900.0						900.0	114300.0	127800.0
			Σ =	**8129.3**			**1058491.8**	**967382.4**	**1316.5**	**1200.0**	**329.1**	**1810.2**	**329.1**	**492820.1**	**450400.7**	**13114.1**	**1732661.9**	**1588333.1**

	xbar	**ybar**		
Center of Mass of Concrete =	**130.2**	**119.0**	**xbar = Σ (Wt * CGXi)/Σ Wt**	**ybar = Σ (Wt * CGYi)/Σ Wt**
Center of Applied Mass =	**98.9**	**90.4**	**xbar = Σ (Wi * CGXi)/Σ Wi**	**ybar = Σ (Wi * CGYi)/Σ Wi**
Centroid of All Masses =	**132.1**	**121.1**	**xbar = Σ (W_{total} * CGXi)/Σ W_{total}**	**ybar = Σ (W_{total} * CGYi)/Σ W_{total}**

**1 For coordinate system definition see page 8.
**2 Numbers and letters are in reference to the column grid lines for the building.
**3 Slab dimensions are all inside face of walls.
**4 Σ Wi = Σ(W1+W2+W3+W4+W5)
**5 Actual Top of Rail elevation is 45' for 200 Ton crane & 59'-11" for Canister Transfer Machine. Apply loads at elevation 64' to be conservative.
Weight Computation: Slab weights are computed as follows Weight = (Length*Width*Thickness*((thickness*.15+.022)/thickness)
the ((thickness*.15+.022)/thickness) term computes a weighted density that accounts for the weight of concrete in the metal decking valley of a three inch metal deck which weighs approximately 22 psf.

Elevation 72' (Upper Roof) (See attachment A, page 33)

Slab (**2)	Width (Xdim) (ft)	Length (Ydim) (ft)	Thickness (ft)	Weight (see below) Wt (kips)	CG Xi (**1) (ft)	CG Yi (**1) (ft)	Wt * CG Xi (ft-kips)	Wt * CG Yi (ft-kips)	Structural Steel Load (40 psf) W1 (kips)	Floor Equipment Dead Load (100 psf) W2 (kips)	Live Load (10 psf) W3 (kips)	Roofing Load (55 psf) W4 (kips)	Roof Equipment Dead Load (10 psf) W5 (kips)	(**4) Wi * CGXi (ft-kips)	(**4) Wi * CGYi (ft-kips)	Total Weight W_{total} (kips)	W_{total} * CGXi (ft-kips)	Wtotal * CGYi (ft-kips)
C-E/6-8	87	70	1.5	1504.2	193.5	119	291068.5	179003.4	243.6	0.0	60.9	335.0	60.9	135517.7	83341.7	2204.6	426586.2	262345.0
			Σ =	**1504.2**			**291068.5**	**179003.4**	**243.6**	**0.0**	**60.9**	**335.0**	**60.9**	**135517.7**	**83341.7**	**2204.6**	**426586.2**	**262345.0**

	xbar	ybar		
Center of Mass of Concrete =	**193.5**	**119.0**	**xbar = Σ (Wt * CGXi)/Σ Wt**	**ybar = Σ (Wt * CGYi)/Σ Wt**
Center of Applied Mass =	**193.5**	**119.0**	**xbar = Σ (Wi * CGXi)/Σ Wi**	**ybar = Σ (Wi * CGYi)/Σ Wi**
Centroid of All Masses =	**193.5**	**119.0**	**xbar = Σ (W_{total} * CGXi)/Σ W_{total}**	**ybar = Σ (W_{total} * CGYi)/Σ W_{total}**

**1 For coordinate system definition see page 8.
**2 Numbers and letters are in reference to the column grid lines for the building.
**3 Slab dimensions are all inside face of walls.
**4 Σ Wi = Σ(W1+W2+W3+W4+W5)

Weight Computation: Slab weights are computed as follows Weight = (Length*Width*Thickness*((thickness*.15+.022)/thickness)
the ((thickness*.15+.022)/thickness) term computes a weighted density that accounts for the weight of concrete in the metal decking valley of a three inch metal deck which weighs approximately 22 psf.

Elevation 100' (Upper Roof) (See attachment A, page 34)

Slab (**2)	Width (Xdim) (ft)	Length (Ydim) (ft)	Thickness (ft)	Weight (see below) Wt (kips)	CG Xi (**1) (ft)	CG Yi (**1) (ft)	Wt * CG Xi (ft-kips)	Wt * CG Yi (ft-kips)	Structural Steel Load (40 psf) W1 (kips)	Floor Equipment Dead Load (100 psf) W2 (kips)	Roof Live Load (10 psf) W3 (kips)	Roofing Load (55 psf) W4 (kips)	Roof Equipment Dead Load (10 psf) W5 (kips)	(**4) Wi * CGXi (ft-kips)	(**4) Wi * CGYi (ft-kips)	Total Weight W_{total} (kips)	W_{total} * CGXi (ft-kips)	Wtotal * CGYi (ft-kips)
C-E/3-6	101	70	1.5	1746.3	95.5	119	166770.7	207808.5	282.8	0.0	70.7	388.9	70.7	77646.3	96753.0	2559.3	244417.0	304561.5
			Σ =	**1746.3**			**166770.7**	**207808.5**	**282.8**	**0.0**	**70.7**	**388.9**	**70.7**	**77646.3**	**96753.0**	**2559.3**	**244417.0**	**304561.5**

	xbar	ybar		
Center of Mass of Concrete =	**95.5**	**119.0**	**xbar = Σ (Wt * CGXi)/Σ Wt**	**ybar = Σ (Wt * CGYi)/Σ Wt**
Center of Applied Mass =	**95.5**	**119.0**	**xbar = Σ (Wi * CGXi)/Σ Wi**	**ybar = Σ (Wi * CGYi)/Σ Wi**
Centroid of All Masses =	**95.5**	**119.0**	**xbar = Σ (W_{total} * CGXi)/Σ W_{total}**	**ybar = Σ (W_{total} * CGYi)/Σ W_{total}**

**1 For coordinate system definition see page 8.
**2 Numbers and letters are in reference to the column grid lines for the building.
**3 Slab dimensions are all inside face of walls.
**4 Σ Wi = Σ(W1+W2+W3+W4+W5)

Weight Computatio Slab weights are computed as follows Weight = (Length*Width*Thickness*((thickness*.15+.022)/thickness)
the ((thickness*.15+.022)/thickness) term computes a weighted density that accounts for the weight of concrete in the metal decking valley of a three inch metal deck which weighs approximately 22 psf.

Walls Elevation 16' to 32' **4 (See attachment A, page 30)

WALL (**2)	start (**3) (ft)	end (**3) (ft)	Length =end-start L (ft)	Height H (ft)	Thickness T (ft)	Weight =L*H*T*0.15 W (kips)	CGx (**1) (ft)	CGy (**1) (ft)	W*CGx ft-kips	W*CGy ft-kips
N/S WALLS EL. 16-32 (4)**										
2	82	156	74	16	2	355.2	0	119	0	42268.8
3	0	238	238	16	4	2284.8	43	119	98246.4	271891.2
4	0	238	238	16	4	2284.8	89	119	203347.2	271891.2
5	82	156	74	16	4	710.4	107	119	76012.8	84537.6
6	0	238	238	16	4	2284.8	148	119	338150.4	271891.2
7-1	0	82	82	16	4	787.2	186.67	41	146946.6	32275.2
7-2	156	238	82	16	4	787.2	186.67	197	146946.6	155078.4
8	0	238	238	16	4	2284.8	239	119	546067.2	271891.2
9	82	156	74	16	2	355.2	282	119	100166.4	42268.8
E/W WALLS EL. 16-32 (4)**										
A	43	239	196	16	4	1881.6	141	238	265305.6	447820.8
B	43	89	46	16	4	441.6	66	199	29145.6	87878.4
C-1	0	43	43	16	2	206.4	21.5	157	4437.6	32404.8
C-2	43	239	196	16	4	1881.6	141	156	265305.6	293529.6
C-3	239	282	43	16	2	206.4	260.5	157	53767.2	32404.8
D-1	43	89	46	16	4	441.6	66	115	29145.6	50784
D-2	107	148	41	16	4	393.6	127.5	115	50184	45264
E-1	0	43	43	16	2	206.4	21.5	81	4437.6	16718.4
E-2	43	239	196	16	4	1881.6	141	82	265305.6	154291.2
E-3	239	282	43	16	2	206.4	260.5	81	53767.2	16718.4
F	43	239	196	16	4	1881.6	141	0	265305.6	0
					TOTAL =	**21763.2**			**2941991**	**2621808**

XBAR = 135.18 (ft) **XBAR = Σ (W*CGx)/Σ W**

YBAR = 120.47 (ft) **YBAR = Σ (W*CGy)/Σ W**

**1 For coordinate system definition see page 8.

**2 Numbers and letters are in reference to the column grid lines for the building (Attachment A).

**3 The start and end dimensions (center to center column line) refer to the axis parallel with the wall. For example, the x-axis is parallel with the East/West walls (E/W). CGx would be calculated as the start plus half the length, and CGz would simply be the perpendicular distance from the wall to the origin. The opposite is true for the North/South wall (N/S).

**4 The walls from elev. 0 to 32' are identical, therefore these results are used for both 0 - 16' and 16' - 32' on the summary sheets.

Walls Elevation 32' to 48' (4)** (See attachment A, page 31)

WALL (**2)	start (**3) (ft)	end (**3) (ft)	Length =end-start L (ft)	Height H (ft)	Thickness T (ft)	Weight =L*H*T*0.15 W (kips)	CGx (**1) (ft)	CGy (**1) (ft)	W*CGx ft-kips	W*CGy ft-kips
N/S WALLS EL. 32-48 (4)**										
2	82	156	74	16	2	355.2	0	119	0	42268.8
3	0	238	238	16	4	2284.8	43	119	98246.4	271891.2
4-1	0	82	82	16	4	787.2	89	41	70060.8	32275.2
4-2	156	238	82	16	4	787.2	89	197	70060.8	155078.4
6	0	238	238	16	4	2284.8	148	119	338150	271891.2
7-1	0	82	82	16	4	787.2	186.67	41	146947	32275.2
7-2	156	238	82	16	4	787.2	186.67	197	146947	155078.4
8	0	238	238	16	4	2284.8	239	119	546067	271891.2
E/W WALLS EL. 32-48 (4)**										
A	43	239	196	16	4	1881.6	141	238	265306	447820.8
B	43	89	46	16	4	441.6	66	199	29145.6	87878.4
C-1	0	43	43	16	2	206.4	21.5	157	4437.6	32404.8
C-2	43	239	196	16	4	1881.6	141	156	265306	293529.6
E-1	0	43	43	16	2	206.4	21.5	81	4437.6	16718.4
E-2	43	239	196	16	4	1881.6	141	82	265306	154291.2
F	43	239	196	16	4	1881.6	141	0	265306	0
					TOTAL =	**18739.2**			**2515722**	**2265292.8**

XBAR = 134.25 (ft) **XBAR = Σ (W*CGx)/Σ W**

YBAR = 120.89 (ft) **YBAR = Σ (W*CGy)/Σ W**

**1 For coordinate system definition see page 8.

**2 Numbers and letters are in reference to the column grid lines for the building (Attachment A).

**3 The start and end dimensions refer to the axis parallel with the wall. For example, the x-axis is parallel with the East/West walls (E/W). CGx would be calculated as the start plus half the length, and CGy would simply be the perpendicular distance from the wall to the origin. The opposite is true for the North/South wall (N/S).

**4 The walls from elev. 48 to 64 are identical, therefore these results are used for both 32 - 48 and 48 - 64 on the summary sheets.

Walls Elevation 64' to 68' (4)** (See attachment A, page 32)

WALL (**2)	start (**3) (ft)	end (**3) (ft)	Length =end-start L(ft)	Height H (ft)	Thickness T (ft)	Weight =L*H*T*0.15 W (kips)	CGx (**1) (ft)	CGy (**1) (ft)	W*CGx ft-kips	W*CGy ft-kips
N/S WALLS EL. 64-68 (4)**										
8	82	156	74	4	4	177.6	239	119	42446.4	21134.4
E/W WALLS EL. 64-68 (4)**										
C	148	239	91	4	4	218.4	193.5	156	42260.4	34070.4
E	148	239	91	4	4	218.4	193.5	82	42260.4	17908.8
					TOTAL =	**614.4**			**126967.2**	**73113.6**

XBAR = 206.65 ft **XBAR = Σ (W*CGx)/Σ W**

YBAR = 119.00 ft **YBAR = Σ (W*CGy)/Σ W**

**1 For coordinate system definition see page 8.

**2 Numbers and letters are in reference to the column grid lines for the building (Attachment A).

**3 The start and end dimensions refer to the axis parallel with the wall. For example, the x-axis is parallel with the East/West walls (E/W). CGx would be calculated as the start plus half the length, and CGy would simply be the perpendicular distance from the wall to the origin. The opposite is true for the North/South wall (N/S).

**4 The walls from elev. 64 to 72 are identical, therefore these results are used for both 64 - 68 and 68 - 72 on the summary sheets.

Walls Elevation 64' to 82' (4)** (See attachment A, page 32)

WALL (**2)	start (**3) (ft)	end (**3) (ft)	Length =end-start L(ft)	Height H (ft)	Thickness T (ft)	Weight =L*H*T*0.15 W (kips)	CGx (**1) (ft)	CGy (**1) (ft)	W*CGx ft-kips	W*CGy ft-kips
N/S WALLS EL. 64-82 (4)**										
3	82	156	74	18	4	799.2	43	119	34365.6	95104.8
6	82	156	74	18	4	799.2	148	119	118282	95104.8
E/W WALLS EL. 64-82 (4)**										
C	43	148	105	18	4	1134	95.5	156	108297	176904
E	43	148	105	18	4	1134	95.5	82	108297	92988
					TOTAL =	**3866.4**			**369241**	**460101.6**

XBAR = 95.50 ft **XBAR = Σ (W*CGx)/Σ W**

YBAR = 119.00 ft **YBAR = Σ (W*CGy)/Σ W**

**1 For coordinate system definition see page 8.

**2 Numbers and letters are in reference to the column grid lines for the building (Attachment A).

**3 The start and end dimensions refer to the axis parallel with the wall. For example, the x-axis is parallel with the East/West walls (E/W). CGx would be calculated as the start plus half the length, and CGy would simply be the perpendicular distance from the wall to the origin. The opposite is true for the North/South wall (N/S).

**4 The walls from elev. 82 to 100 are identical, therefore these results are used for both 64 - 82 and 82 - 100 on the summary sheets.

WEIGHTS AND CENTERS OF MASS

Note: For coordinate system defination see page 8.

BASESLAB + WALLS	Weight W (kips)	xbar (ft)	ybar (ft)	W*xbar (ft - kips)	W*ybar (ft - kips)
BASESLAB @ 0'	54751.2	141.00	119.00	7719919.2	6515392.8
STRUCTURAL STEEL	549.5	141.00	119.00	77482.3	65392.9
EQUIP. DEAD LOAD	5495.2	141.00	119.00	774823.2	653928.8
LIVE LOAD	1373.8	141.00	119.00	193705.8	163482.2
WALLS 0-16	21763.2	135.18	120.47	2941990.8	2621808.0
SUM	**83932.9**			**11707921.4**	**10020004.7**

	XBAR =	139.49	ft		XBAR = Σ(W*xbar)/Σ(W)
BASESLAB	YBAR =	119.38	ft		YBAR = Σ(W*ybar)/S(W)
	WEIGHT	83932.9	kips		WEIGHT = Σ(Weight)

32' FLOOR SLAB & LOWER ROOF AND WALLS	Weight W (kips)	xbar (ft)	ybar (ft)	W*xbar (ft - kips)	W*ybar (ft - kips)
FLOOR SLAB @ 32'	12003.7	120.14	116.25	1442156.8	1395436.3
STRUCTURAL STEEL	1514.6	127.13	115.47	192544.5	174888.7
EQUIP. DEAD LOAD	3786.4	127.13	115.47	481361.3	437221.7
LIVE LOAD	946.6	127.13	115.47	120340.3	109305.4
LOWER ROOF SLAB @ 32'	1071.5	261.00	119.00	279666.7	127510.9
STRUCTURAL STEEL	118.4	261.00	119.00	30902.4	14089.6
LIVE LOAD	29.6	261.00	119.00	7725.6	3522.4
ROOFING	162.8	261.00	119.00	42490.8	19373.2
ROOF EQUIP. DEAD LOAD	29.6	261.00	119.00	7725.6	3522.4
WALLS 16-32	21763.2	135.18	120.47	2941990.8	2621808.0
WALLS 32-48	18739.2	134.25	120.89	2515722.0	2265292.8
SUM	**60165.5**			**8062626.9**	**7171971.4**

	XBAR =	134.01	ft		XBAR = Σ(W*xbar)/Σ(W)
32' SLAB & LR	YBAR =	119.20	ft		YBAR = Σ(W*ybar)/S(W)
	WEIGHT	60165.5	kips		WEIGHT = Σ(Weight)

64' MR + WALLS + CRANES	Weight W (kips)	xbar (ft)	ybar (ft)	W*xbar (ft - kips)	W*ybar (ft - kips)
MIDDLE ROOF SLAB @ 64'	8129.3	130.21	119.00	1058491.8	967382.4
STRUCTURAL STEEL	1316.5	98.86	90.35	130151.1	118948.4
LIVE LOAD	329.1	98.86	90.35	32537.8	29737.1
ROOFING	1810.2	98.86	90.35	178957.8	163554.1
ROOF EQUIP. DEAD LOAD	329.1	98.86	90.35	32537.8	29737.1
WALLS 48-64	18739.2	134.25	120.89	2515722.0	2265292.8
WALLS 64-82	3866.4	95.50	119.00	369241.2	460101.6
WALLS 64-68	614.4	206.65	119.00	126967.2	73113.6
CRANE IN PREP AREA	300.0	223.50	142.50	67050.0	42750.0
CANISTER TRANSFER MACHINE	900.0	127.00	142.00	114300.0	127800.0
SUM	**36334.1**			**4625956.8**	**4278417.1**

	XBAR =	127.32	ft		XBAR = Σ(W*xbar)/Σ(W)
64' MIDDLE RF	YBAR =	117.75	ft		YBAR = Σ(W*ybar)/S(W)
	WEIGHT	36334.1	kips		WEIGHT = Σ(Weight)

WEIGHTS AND CENTERS OF MASS (CONTINUE)

Note: For coordinate system defination see page 8.

72' UPPER ROOF		Weight W (kips)	xbar (ft)	ybar (ft)	W*xbar (ft - kips)	W*ybar (ft - kips)
UPPER ROOF SLAB @ 72'		1504.2	193.50	119.00	291068.5	179003.4
STRUCTURAL STEEL		243.6	193.50	119.00	47136.6	28988.4
LIVE LOAD		60.9	193.50	119.00	11784.2	7247.1
ROOFING		335.0	193.50	119.00	64812.8	39859.1
ROOF EQUIP. DEAD LOAD		60.9	193.50	119.00	11784.2	7247.1
WALLS 68-72		614.4	206.65	119.00	126967.2	73113.6
	SUM	**2819.0**			**553553.4**	**335458.6**

72' UPPER RF	**XBAR =**	**196.37**	ft	**XBAR = Σ(W*xbar)/Σ(W)**
	YBAR =	**119.00**	ft	**YBAR = Σ(W*ybar)/S(W)**
	WEIGHT	**2819.0**	kips	**WEIGHT = Σ(Weight)**

100' UPPER ROOF		Weight W (kips)	xbar (ft)	ybar (ft)	W*xbar (ft - kips)	W*ybar (ft - kips)
UPPER ROOF SLAB @ 100'		1746.3	95.50	119.00	166770.7	207808.5
STRUCTURAL STEEL		282.8	95.50	119.00	27007.4	33653.2
LIVE LOAD		70.7	95.50	119.00	6751.9	8413.3
ROOFING		388.9	95.50	119.00	37135.2	46273.2
ROOF EQUIP. DEAD LOAD		70.7	95.50	119.00	6751.9	8413.3
WALLS 82-100		3866.4	95.50	119.00	369241.2	460101.6
	SUM	**6425.7**			**613658.2**	**764663.1**

100' UPPER RF	**XBAR =**	**95.50**	ft	**XBAR = Σ(W*xbar)/Σ(W)**
	YBAR =	**119.00**	ft	**YBAR = Σ(W*ybar)/S(W)**
	WEIGHT	**6425.7**	kips	**WEIGHT = Σ(Weight)**

MASS MOMENTS OF INERTIA (for computing mass moment of inertia of a slab about its centroid see reference below)

Note: For coordinate system defination see page 8.

BASESLAB @ 0' + WALLS 0' - 16' **CGx = 139.49** **CGy = 119.38**

Area Description	Length x Lx (ft)	Length y Ly (ft)	Total Weight (W) (kips)	CGxi (ft)	CGyi (ft)	Iox W*Ly^2/12g (kip-ft-sec^2)	mdy^2 W*(CGy-CGyi)^2/g (kip-ft-sec^2)	Ioy W*Lx^2/12g (kip-ft-sec^2)	mdx^2 W*(CGx-CGxi)^2/g (kip-ft-sec^2)
Baseslab @ 0'									
C-E/2-3	42	78	2407.9	20	119	3.79E+04	1.09E+01	1.10E+04	1.07E+06
A-F/3-8	200	242	57354.0	141	119	8.69E+06	2.59E+02	5.94E+06	4.05E+03
C-E/8-9	42	78	2407.9	262	119	3.79E+04	1.09E+01	1.10E+04	1.12E+06
N/S Walls 0' - 16' (See N/S Walls 16' - 32')									
2			355.2	0.0	119.0		1.60E+00		2.15E+05
3			2284.8	43.0	119.0		1.03E+01		6.61E+05
4			2284.8	89.0	119.0		1.03E+01		1.81E+05
5			710.4	107.0	119.0		3.20E+00		2.33E+04
6			2284.8	148.0	119.0		1.03E+01		5.14E+03
7-1			787.2	186.7	41.0		1.50E+05		5.44E+04
7-2			787.2	186.7	197.0		1.47E+05		5.44E+04
8			2284.8	239.0	119.0		1.03E+01		7.03E+05
9			355.2	282.0	119.0		1.60E+00		2.24E+05
E/W Walls 0' - 16' (See E/W Walls 16' - 32')									
A			1881.6	141.0	238.0		8.22E+05		1.33E+02
B			441.6	66.0	199.0		8.69E+04		7.41E+04
C-1			206.4	21.5	157.0		9.07E+03		8.92E+04
C-2			1881.6	141.0	156.0		7.84E+04		1.33E+02
C-3			206.4	260.5	157.0		9.07E+03		9.39E+04
D-1			441.6	66.0	115.0		2.63E+02		7.41E+04
D-2			393.6	127.5	115.0		2.35E+02		1.76E+03
E-1			206.4	21.5	81.0		9.44E+03		8.92E+04
E-2			1881.6	141.0	82.0		8.17E+04		1.33E+02
E-3			206.4	260.5	81.0		9.44E+03		9.39E+04
F			1881.6	141.0	0.0		8.33E+05		1.33E+02
		Σ	8.39E+04			8.77E+06	2.24E+06	5.96E+06	4.83E+06

Mass Moment of Inertia about x-axis Ix =	1.10E+07	kip-ft-sec^2	Σ(Iox + mdy2)
Mass Moment of Inertia about y-axis Iy =	1.08E+07	kip-ft-sec^2	Σ(Ioy + mdx2)
Mass Moment of Inertia about z-axis Iz = Ix + Iy =	2.18E+07	kip-ft-sec^2	

Mass Moment of Inertia of slab about its centroid from "Dynamics of Structures" Ray W. Clough and Joseph Penzien, 1975. Page 24 (Ref. 2.1.2)

MASS MOMENTS OF INERTIA (for computing mass moment of inertia of a slab about its centroid see reference below)
Note: For coordinate system defination see page 8.
FLOOR SLABS @ 32' + WALLS 16'- 32' + WALLS 32'-48' + LOWER ROOF SLABS @ 32'
CGx = 134.01 CGy = 119.20

Area Description	Length x Lx (ft)	Length y Ly (ft)	Total Weight $W = W_t + W_i$ (kips)	CGxi (ft)	CGyi (ft)	Iox W*Ly^2/12g (kip-ft-sec^2)	mdy^2 W*(CGy-CGyi)^2/g (kip-ft-sec^2)	Ioy W*Lx^2/12g (kip-ft-sec^2)	mdx^2 W*(CGx-CGxi)^2/g (kip-ft-sec^2)
Floor Slabs @ 32'									
A-B/3-4	42	35	605.6	66.0	218.5	1.92E+03	1.85E+05	2.76E+03	8.70E+04
A-C/4-8	146	78	4691.9	164.0	197.0	7.39E+04	8.82E+05	2.59E+05	1.31E+05
C-E/2-3	40	74	1219.5	21.0	119.0	1.73E+04	1.58E+00	5.05E+03	4.84E+05
C-E/3-6	101	70	5564.1	95.5	119.0	7.06E+04	7.19E+00	1.47E+05	2.56E+05
E-F/3-8	192	78	6170.1	141.0	41.0	9.72E+04	1.17E+06	5.89E+05	9.37E+03
N/S Walls 16' - 32' (See N/S Walls 0' - 16')									
2			355.2	0	119		4.59E-01		1.98E+05
3			2284.8	43	119		2.95E+00		5.88E+05
4			2284.8	89	119		2.95E+00		1.44E+05
5			710.4	107	119		9.18E-01		1.61E+04
6			2284.8	148	119		2.95E+00		1.39E+04
7-1			787.2	186.67	41		1.50E+05		6.78E+04
7-2			787.2	186.67	197		1.48E+05		6.78E+04
8			2284.8	239	119		2.95E+00		7.82E+05
9			355.2	282	119		4.59E-01		2.42E+05
E/W Walls 16' - 32' (See E/W Walls 0' - 16')									
A			1881.6	141.0	238.0		8.25E+05		2.86E+03
B			441.6	66.0	199.0		8.73E+04		6.34E+04
C-1			206.4	21.5	157.0		9.16E+03		8.11E+04
C-2			1881.6	141.0	156.0		7.91E+04		2.86E+03
C-3			206.4	260.5	157.0		9.16E+03		1.03E+05
D-1			441.6	66.0	115.0		2.42E+02		6.34E+04
D-2			393.6	127.5	115.0		2.16E+02		5.18E+02
E-1			206.4	21.5	81.0		9.36E+03		8.11E+04
E-2			1881.6	141.0	82.0		8.09E+04		2.86E+03
E-3			206.4	260.5	81.0		9.36E+03		1.03E+05
F			1881.6	141.0	0.0		8.30E+05		2.86E+03
N/S Walls 32' - 48'									
2			355.2	0.0	119.0		4.59E-01		1.98E+05
3			2284.8	43.0	119.0		2.95E+00		5.88E+05
4-1			787.2	89.0	41.0		1.50E+05		4.95E+04
4-2			787.2	89.0	197.0		1.48E+05		4.95E+04
6			2284.8	148.0	119.0		2.95E+00		1.39E+04
7-1			787.2	186.7	41.0		1.50E+05		6.78E+04
7-2			787.2	186.7	197.0		1.48E+05		6.78E+04
8			2284.8	239.0	119.0		2.95E+00		7.82E+05
E/W Walls 32' - 48'									
A			1881.6	141	238		8.25E+05		2.86E+03
B			441.6	66	199		8.73E+04		6.34E+04
C-1			206.4	21.5	157		9.16E+03		8.11E+04
C-2			1881.6	141	156		7.91E+04		2.86E+03
E-1			206.4	21.5	81		9.36E+03		8.11E+04
E-2			1881.6	141	82		8.09E+04		2.86E+03
F			1881.6	141	0		8.30E+05		2.86E+03
Lower Roof Slabs @ 32'									
C-E/8-9	40	74	1071.52	261	119	1.52E+04	1.38E+00	4.44E+03	5.13E+04
		Σ	5.98E+04			2.76E+05	6.99E+06	1.01E+06	5.70E+06

Mass Moment of Inertia about x-axis Ix = 7.27E+06 kip-ft-sec^2 Σ(Iox + mdy2)
Mass Moment of Inertia about y-axis Iy = 6.70E+06 kip-ft-sec^2 Σ(Ioy + mdx2)
Mass Moment of Inertia about y-axis Iz = Ix + Iy = 1.40E+07 kip-ft-sec^2

Mass Moment of Inertia of slab about its centroid from "Dynamics of Structures" Ray W. Clough and Joseph Penzien, 1975. Page 24 (Ref. 2.1.2)

MASS MOMENTS OF INERTIA (for computing mass moment of inertia of a slab about its centroid see reference below)
Note: For coordinate system defination see page 8.
MIDDLE ROOF SLABS @ 64' + WALLS 48' - 64' + WALLS 64' - 82 + WALLS 64' - 68'
CGx = 127.32 CGy = 117.75

Area Description	Length x Lx (ft)	Length y Ly (ft)	Total Weight $W = W_t + W_i$ (kips)	CGxi (ft)	CGyi (ft)	Iox W*Ly^2/12g (kip-ft-sec^2)	mdy^2 W*(CGy-CGyi)^2/g (kip-ft-sec^2)	Ioy W*Lx^2/12g (kip-ft-sec^2)	mdx^2 W*(CGx-CGxi)^2/g (kip-ft-sec^2)
Middle Roof Slabs @ 64'									
A-C/3-8	192	78	5421.3	141	197	8.54E+04	1.06E+06	5.17E+05	3.15E+04
E-F/3-8	192	78	5421.3	141	41	8.54E+04	9.92E+05	5.17E+05	3.15E+04
C-E/2-3	40	74	1071.5	21	119	1.52E+04	5.18E+01	4.44E+03	3.76E+05
Crane in Prep Area			300.0	223.5	142.5		5.71E+03		8.62E+04
C.T.M.			900.0	127	142		1.64E+04		2.81E+00
N/S Walls 48' - 64' (See N/S Walls 32' - 48')									
2			355.2	0.0	119.0		1.72E+01		1.79E+05
3			2284.8	43.0	119.0		1.11E+02		5.04E+05
4-1			787.2	89.0	41.0		1.44E+05		3.59E+04
4-2			787.2	89.0	197.0		1.54E+05		3.59E+04
6			2284.8	148.0	119.0		1.11E+02		3.04E+04
7-1			787.2	186.7	41.0		1.44E+05		8.61E+04
7-2			787.2	186.7	197.0		1.54E+05		8.61E+04
8			2284.8	239.0	119.0		1.11E+02		8.85E+05
E/W Walls 48' - 64' (See E/W Walls 32' - 48')									
A			1881.6	141	238		8.45E+05		1.09E+04
B			441.6	66.0	199.0		9.05E+04		5.16E+04
C-1			206.4	21.5	157.0		9.87E+03		7.18E+04
C-2			1881.6	141.0	156.0		8.55E+04		1.09E+04
E-1			206.4	21.5	81.0		8.66E+03		7.18E+04
E-2			1881.6	141.0	82.0		7.47E+04		1.09E+04
F			1881.6	141.0	0.0		8.10E+05		1.09E+04
N/S Walls 64' -68'									
8			177.6	239	119		8.59E+00		6.88E+04
E/W Walls 64' -68'									
C			218.4	193.5	156		9.92E+03		2.97E+04
E			218.4	193.5	82		8.67E+03		2.97E+04
N/S Walls 64' - 82' (See N/S Walls 82' - 100')									
3			799.2	43	119		3.87E+01		1.76E+05
6			799.2	148	119		3.87E+01		1.06E+04
E/W Walls 64' - 82' (See N/S Walls 82' - 100')									
C			1134	95.5	156		5.15E+04		3.57E+04
E			1134	95.5	82		4.50E+04		3.57E+04
		Σ	3.63E+04			1.86E+05	4.71E+06	1.04E+06	2.99E+06

Mass Moment of Inertia about x-axis Ix = 4.89E+06 kip-ft-sec^2 Σ(Iox + mdy2)
Mass Moment of Inertia about y-axis Iy = 4.03E+06 kip-ft-sec^2 Σ(Ioy + mdx2)
Mass Moment of Inertia about y-axis Iz = Ix + Iy = 8.92E+06 kip-ft-sec^2

Mass Moment of Inertia of slab about its centroid from "Dynamics of Structures" Ray W. Clough and Joseph Penzien, 1975. Page 24 (Ref. 2.1.2)

MASS MOMENTS OF INERTIA (for computing mass moment of inertia of a slab about its centroid see reference below)
Note: For coordinate system defination see page 8.
UPPER ROOF SLAB @ 72' + WALLS 68' - 72'

CGx = 196.37 **CGy = 119.00**

Area Description	Length x Lx (ft)	Length y Ly (ft)	Total Weight $W = W_t + W_i$ (kips)	CGxi (ft)	CGyi (ft)	Iox W*Ly^2/12g (kip-ft-sec^2)	mdy^2 W*(CGy-CGyi)^2/g (kip-ft-sec^2)	Ioy W*Lx^2/12g (kip-ft-sec^2)	mdx^2 W*(CGx-CGxi)^2/g (kip-ft-sec^2)
Upper Roof Slab @ 72'									
C-E/6-8	87	70	2204.6	193.5	119	2.80E+04	0.00E+00	4.32E+04	5.63E+02
N/S Walls 68' - 72' (See N/S Walls 64' - 68')									
8			177.6	239	119		0.00E+00		1.00E+04
E/W Walls 68' - 72' (See E/W Walls 64' - 68')									
C			218.4	193.5	156		9.29E+03		5.57E+01
E			218.4	193.5	82		9.29E+03		5.57E+01
		Σ	2.82E+03			2.80E+04	1.86E+04	4.32E+04	1.07E+04

Mass Moment of Inertia about x-axis Ix =	4.65E+04	kip-ft-sec^2	Σ(Iox + mdy2)
Mass Moment of Inertia about y-axis Iy =	5.39E+04	kip-ft-sec^2	Σ(Ioy + mdx2)
Mass Moment of Inertia about y-axis Iz = Ix + Iy =	1.00E+05	kip-ft-sec^2	

Mass Moment of Inertia of slab about its centroid from "Dynamics of Structures" Ray W. Clough and Joseph Penzien, 1975. Page 24 (Ref. 2.1.2)

MASS MOMENTS OF INERTIA (for computing mass moment of inertia of a slab about its centroid see reference below)
Note: For coordinate system defination see page 8.
UPPER ROOF SLAB @ 100' + WALLS 82' - 100'
CGx = 95.50 **CGy = 119.00**

Area Description	Length x Lx (ft)	Length y Ly (ft)	Total Weight $W = W_t + W_i$ (kips)	CGxi (ft)	CGyi (ft)	Iox W*Ly^2/12g (kip-ft-sec^2)	mdy^2 W*(CGy-CGyi)^2/g (kip-ft-sec^2)	Ioy W*Lx^2/12g (kip-ft-sec^2)	mdx^2 W*(CGx-CGxi)^2/g (kip-ft-sec^2)
Upper Roof Slab @ 100'									
C-E/3-6	101	70	2559.3	95.5	119	3.25E+04	1.61E-26	6.76E+04	1.61E-26
N/S Walls 82' - 100' (See N/S Walls 64' - 82')									
3			799.2	43	119		5.01E-27		6.84E+04
6			799.2	148	119		5.01E-27		6.84E+04
E/W Walls 82' - 100' (See E/W Walls 64' - 82')									
C			1134	95.5	156		4.82E+04		7.11E-27
E			1134	95.5	82		4.82E+04		7.11E-27
		Σ	6.43E+03			3.25E+04	9.64E+04	6.76E+04	1.37E+05

Mass Moment of Inertia about x-axis Ix =	1.29E+05	kip-ft-sec^2	Σ(Iox + mdy2)
Mass Moment of Inertia about y-axis Iy =	2.04E+05	kip-ft-sec^2	Σ(Ioy + mdx2)
Mass Moment of Inertia about y-axis Iz = Ix + Iy =	3.33E+05	kip-ft-sec^2	

Mass Moment of Inertia of slab about its centroid from "Dynamics of Structures" Ray W. Clough and Joseph Penzien, 1975. Page 24 (Ref. 2.1.2)

SUMMARY OF MASS & CENTERS OF MASS

For WEIGHT, XBAR and YBAR, see pages 19 and 20.

	WEIGHT (W) (kips)	**MASS (W/g)** (kip-sec^2/ft) g = 32.2 ft/sec^2	**XBAR** (ft) *	**YBAR** (ft) *
BASE SLAB @ 0' + WALLS (0-16')	83932.9	2606.6	139.49	119.38
FLOOR/ROOF SLAB @ 32' + WALLS (16'-32' & 32'-48')	60165.5	1868.5	134.01	119.20
MIDDLE ROOF @ 64' + WALLS (48'-64' & 64'-68' & 82')	36334.1	1128.4	127.32	117.75
UPPER ROOF @ 72' + WALLS (68'-72')	2819.0	87.5	196.37	119.00
UPPER ROOF @ 100' + WALLS (82'-100')	6425.7	199.6	95.50	119.00
TOTAL	189677.3	5890.6		

* for coordinate system defination see page 8.

SUMMARY OF MASS MOMENT OF INERTIA

	Ix (kip-ft-sec^2)	**Iy** (kip-ft-sec^2)	**MASS (W/g)** (kip-sec^2/ft)	**d** (ft)	**md^2** (kip-ft-sec^2) *	**Ix + md^2** (kip-ft-sec^2)	**Iy + md^2** (kip-ft-sec^2)	**Iz=Ix+Iy** (kip-ft-sec^2)
BASE SLAB @ 0' + WALLS	1.10E+07	1.08E+07	2606.61	0.00	0.00E+00	1.10E+07	1.08E+07	2.18E+07
FLOOR/ROOF SLAB @ 32' + WALLS	7.27E+06	6.70E+06	1868.49	32.00	1.91E+06	9.18E+06	8.62E+06	1.40E+07
MIDDLE ROOF @ 64' + WALLS	4.89E+06	4.03E+06	1128.39	64.00	4.62E+06	9.51E+06	8.65E+06	8.92E+06
UPPER ROOF @ 72' + WALLS	4.65E+04	5.39E+04	87.55	72.00	4.54E+05	5.00E+05	5.08E+05	1.00E+05
UPPER ROOF @ 100' + WALLS	1.29E+05	2.04E+05	199.56	100.00	2.00E+06	2.12E+06	2.20E+06	3.33E+05
TOTAL @ TOP OF BASESLAB @ EL 0'-0"			5890.60			3.23E+07	3.08E+07	4.51E+07

* Use parallel axis theorem to transfer mass moment of inertia @ height "d" to top of base slab @ el. 0'-0".
Ix and Iy from pages 21 through 25

7. RESULTS AND CONCLUSIONS

7.1 RESULTS

The results from this calculation are as follows.

- Mass and centers of mass of each floor and roof level (See page 26 for summary.)
- Mass moments of inertia (See page 27 for summary.)

These results form the basis of the lumped mass stick model used in the seismic analysis of the RF. Results from this calculation are directly used in calculating the damping values (Ref. 2.3.1) and defining the mass properties for seismic lumped mass stick model (Ref. 2.3.2).

7.2 CONCLUSIONS

The outputs of the calculation are reasonable based on the inputs and also are bounding with respect to their usage. Therefore, the results are adequate for use in the structural design calculations being performed as part of the Tier 1 seismic analysis.

ATTACHMENT A

Receipt Facility (RF) Plans and Sections

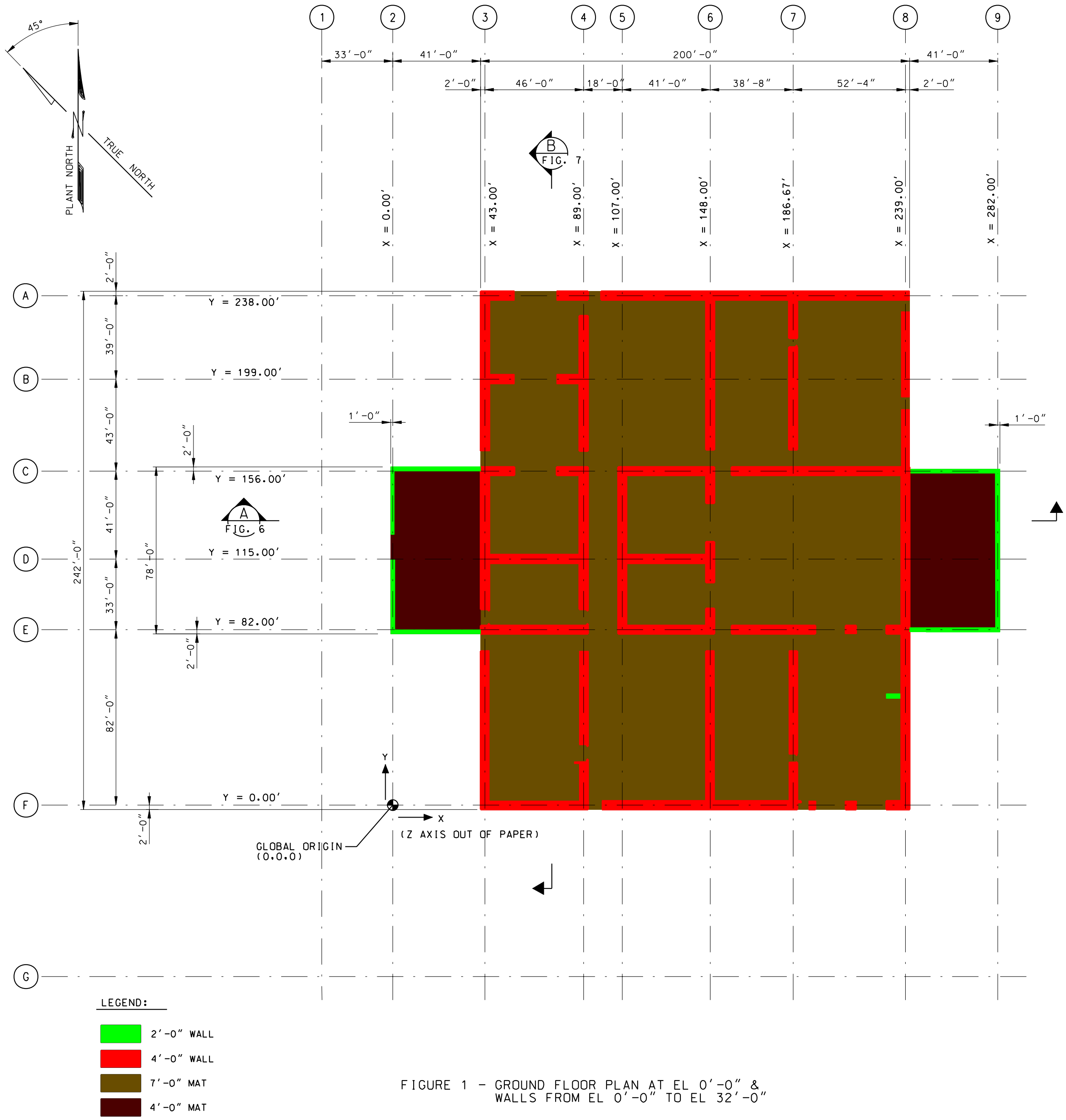


FIGURE 1 - GROUND FLOOR PLAN AT EL 0'-0" & WALLS FROM EL 0'-0" TO EL 32'-0"

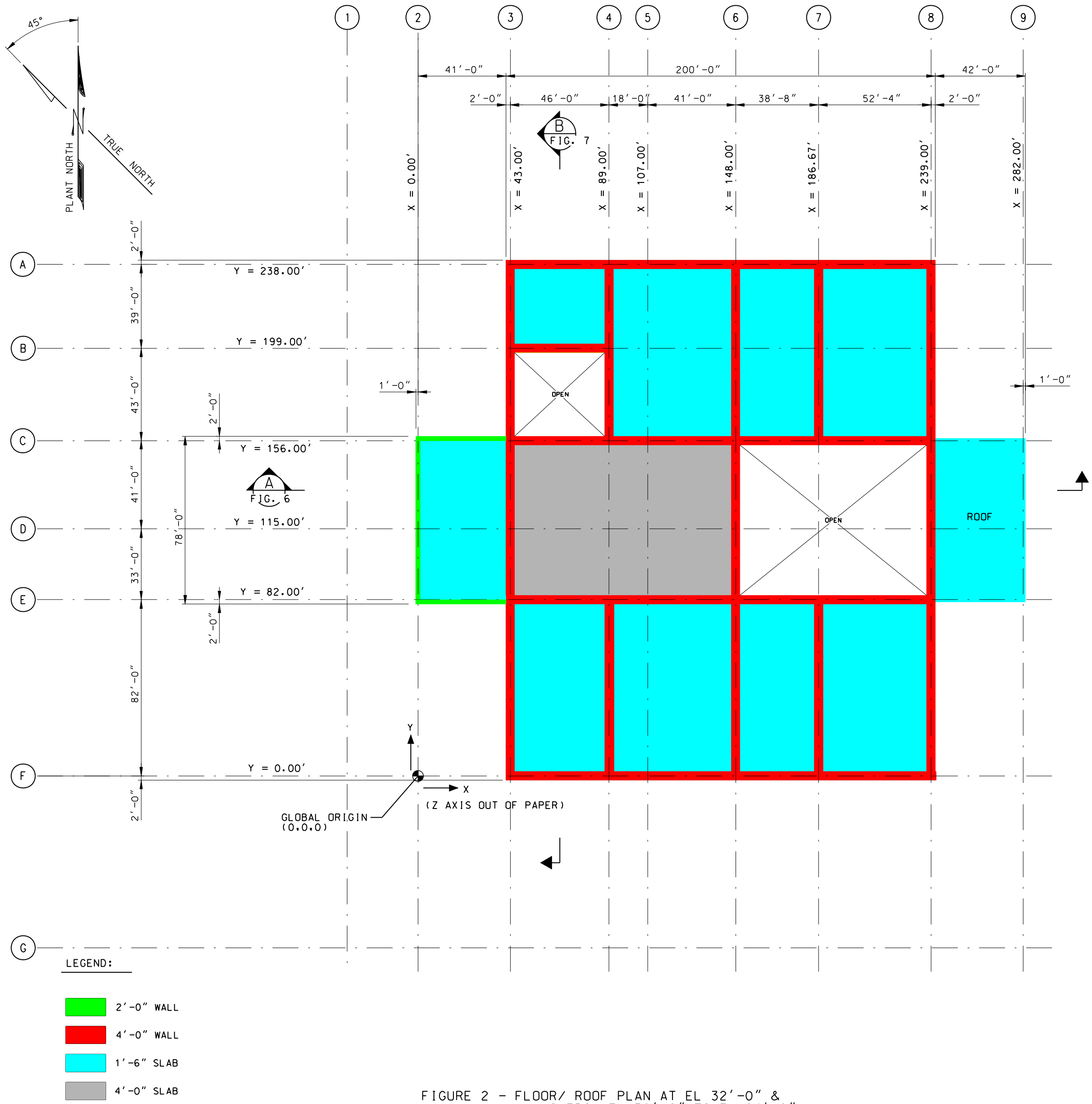


FIGURE 2 - FLOOR/ ROOF PLAN AT EL 32'-0" &
WALLS FROM EL 32'-0" TO EL 64'-0"

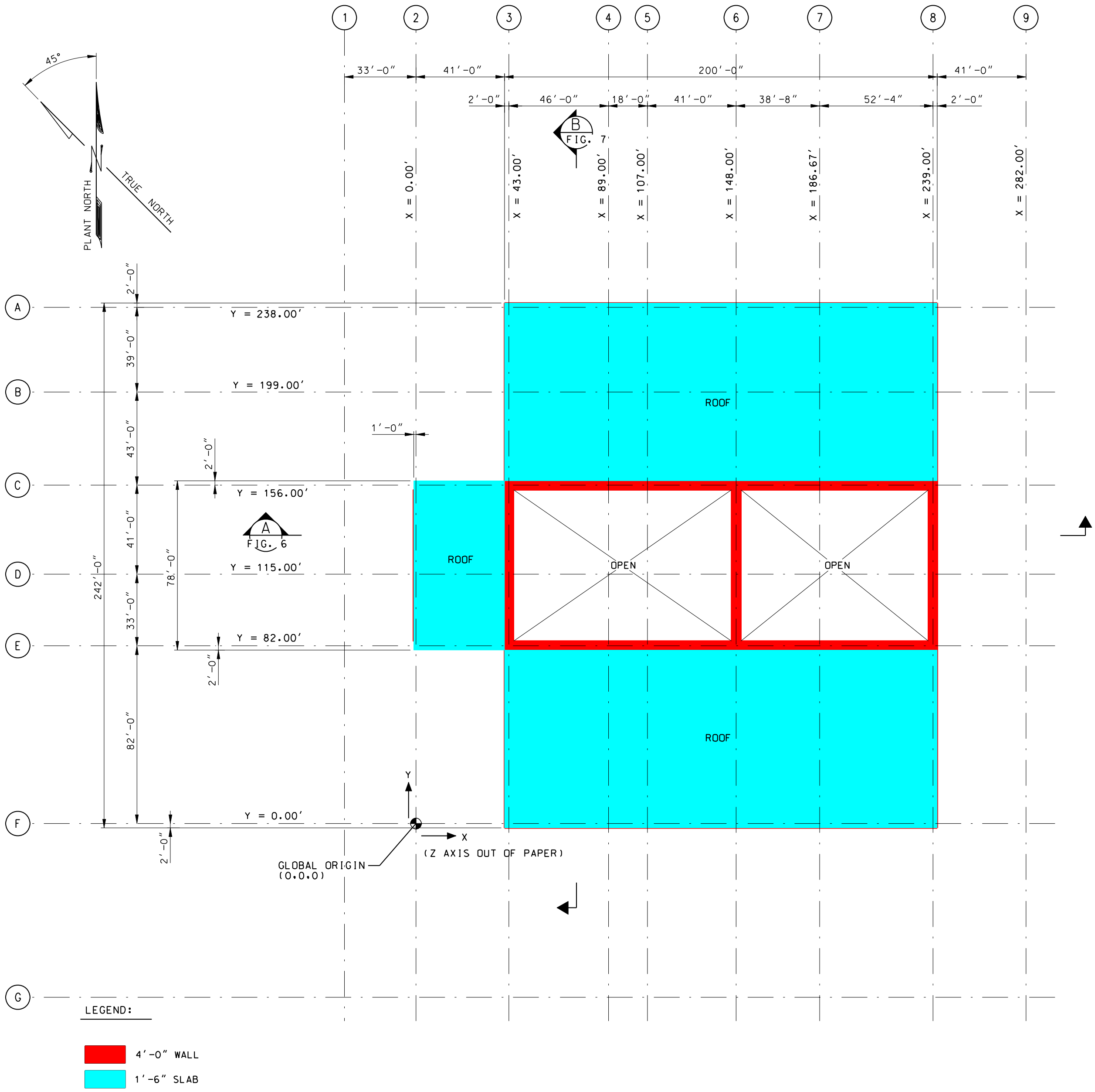


FIGURE 3 - ROOF PLAN AT EL 64'-0" & WALLS FROM EL 64-0" TO EL 72'-0" & 100'-0"

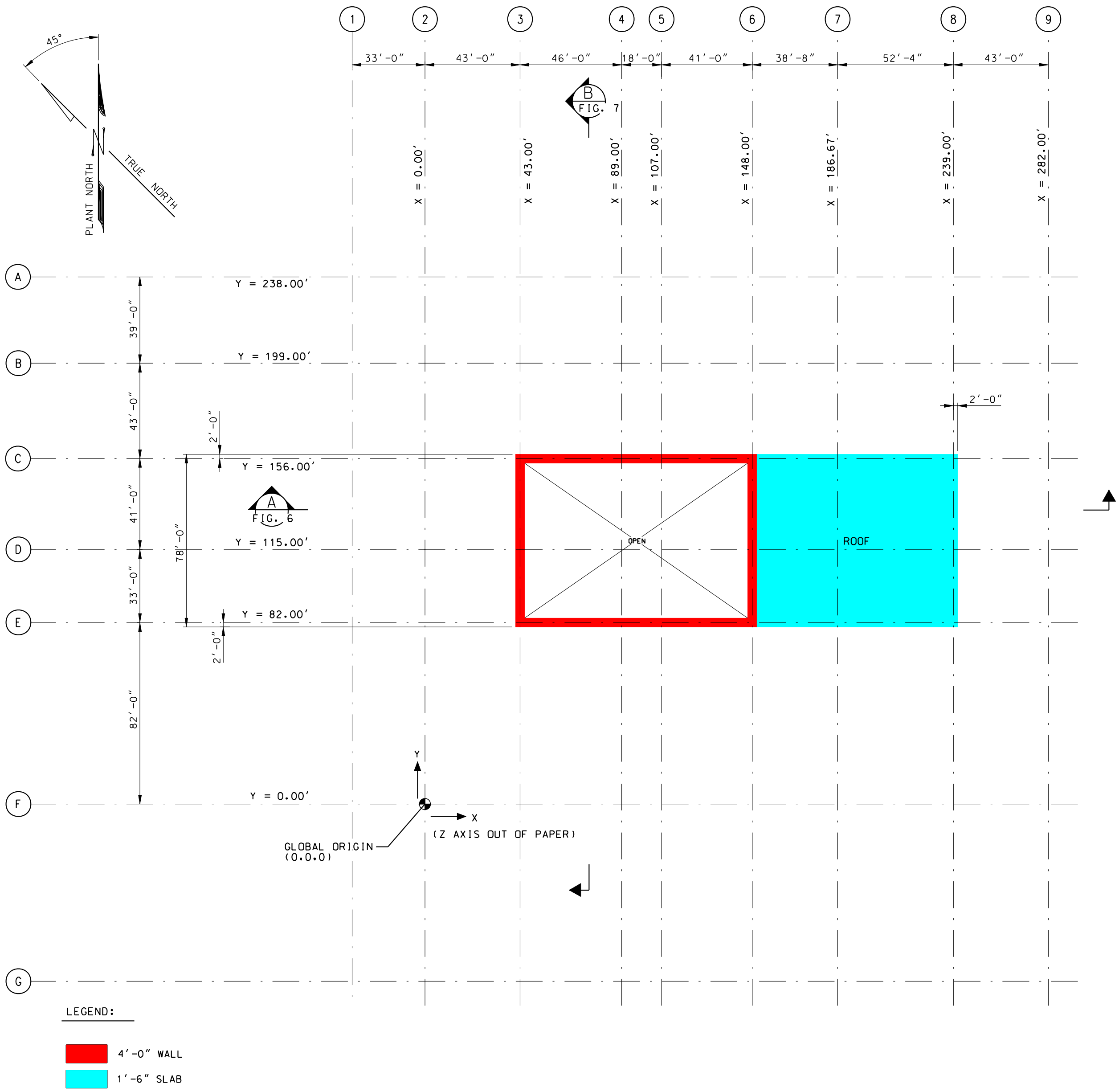


FIGURE 4 - ROOF PLAN AT EL 72'-0" & WALLS FROM EL 72-0" TO EL 100'-0"

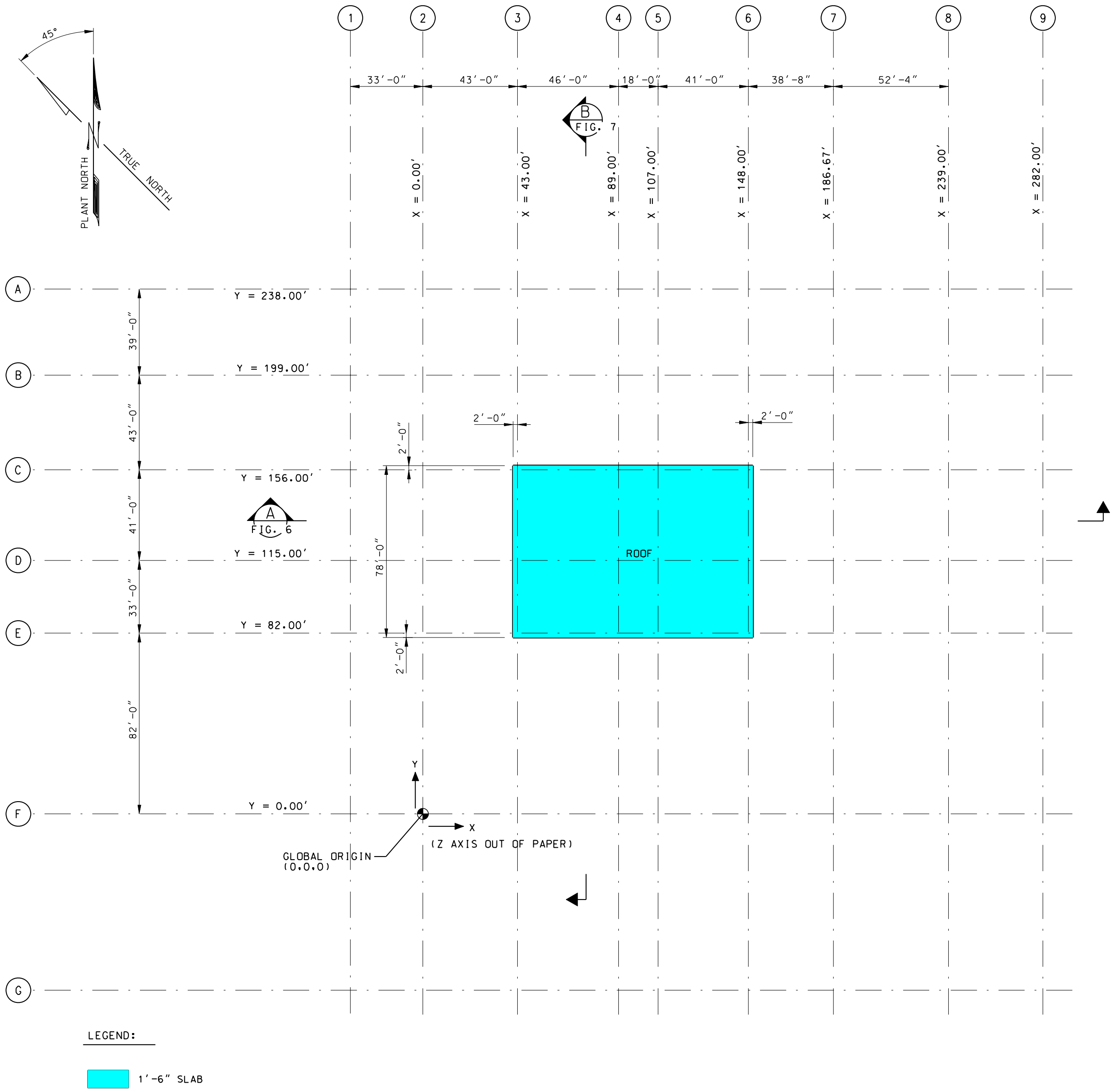


FIGURE 5 - ROOF PLAN AT EL 100'-0"

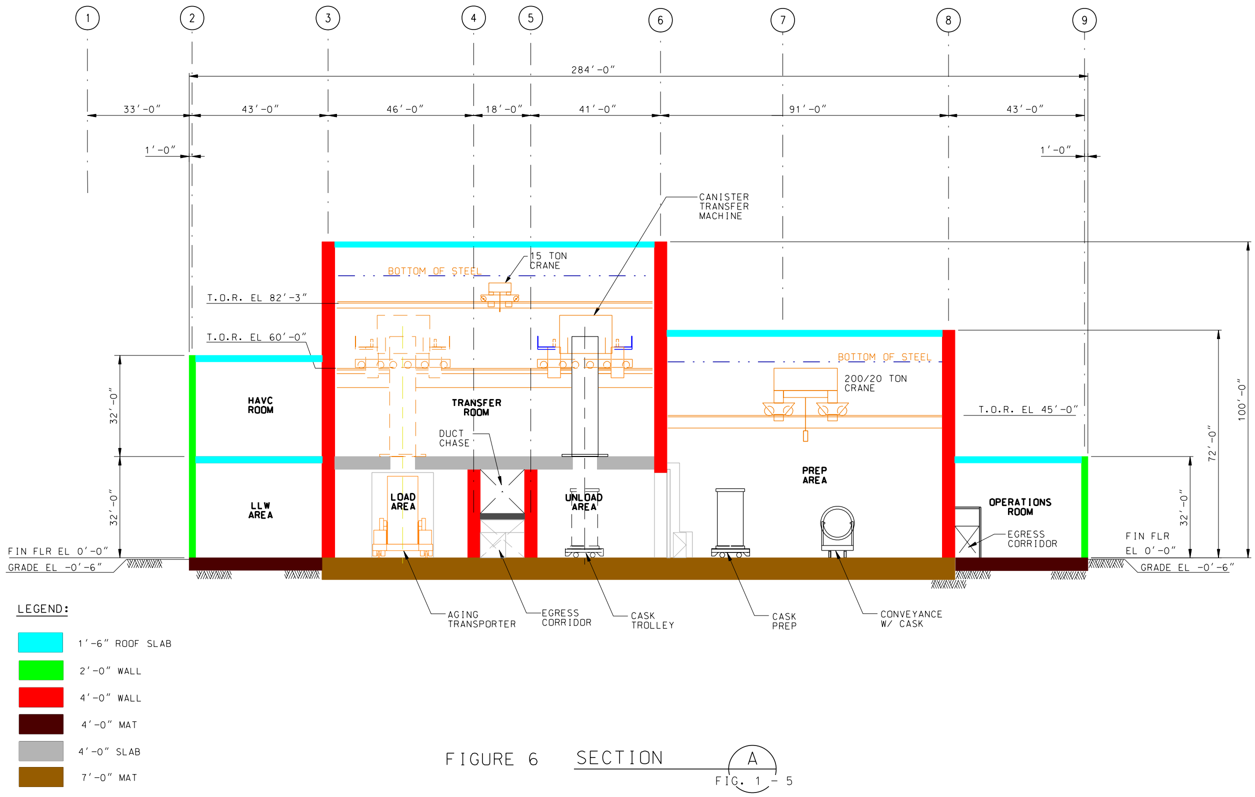


FIGURE 6 SECTION A FIG. 1 - 5

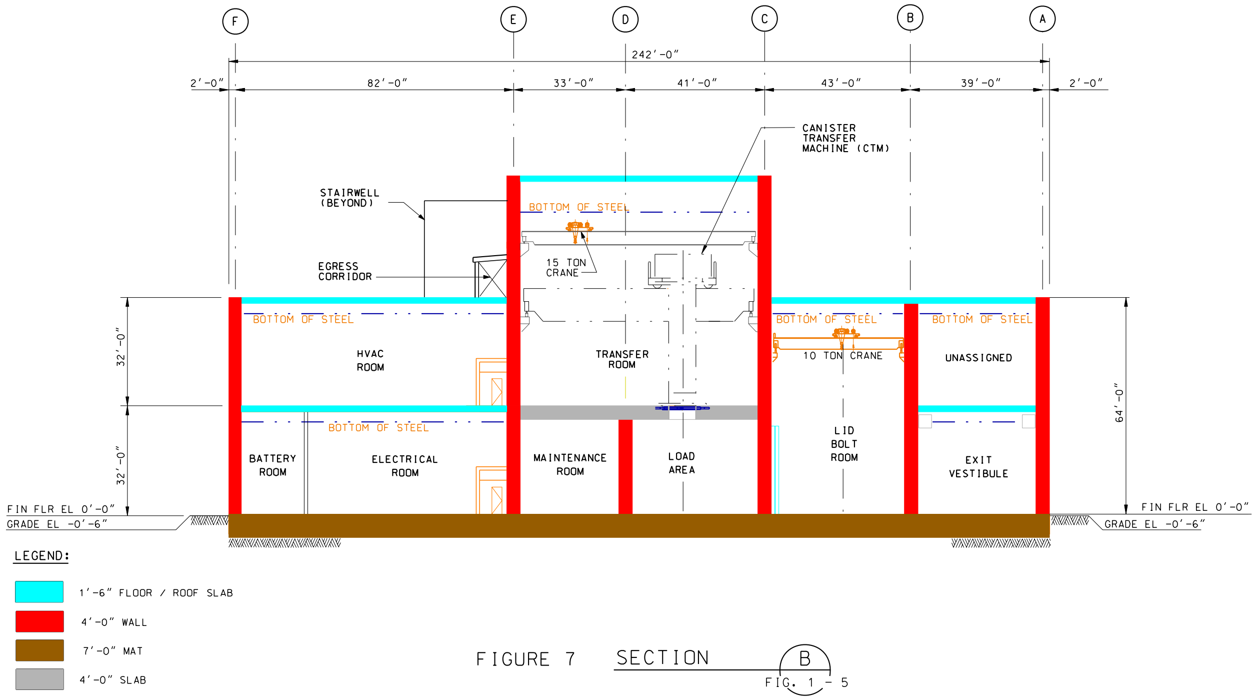


FIGURE 7 SECTION B
FIG. 1 - 5