ASCE 41-17 Tier 1 Seismic Evaluation
Building Name: Central Heating Plant
CAAN ID: 1374
Auxiliary Building ID: N/A
Address: 209 Frank Schlessinger Way, Berkeley, CA
Site location coordinates: Latitude 37.87039 Longitudinal -122.26348

Plan Image or Aerial Photo

Exterior Elevation Photo

UCOP *SEISMIC PERFORMANCE LEVEL* (OR "RATING") BASED ON TIER 1 EVALUATION FINDINGS: IV

BUILDING DATA
ASCE 41-17 Model Building Type (Governing Building Type bolded for Seismic Risk Model when multiple types exist):

a. Longitudinal Direction: C2, Concrete Shear Wall – rigid diaphragm
b. Transverse Direction: C2, Concrete Shear Wall – rigid diaphragm

Square Footage: 8213 SF (out of 20,385 SF total for the building)
Building Length: 97'
Building Width: 76.5'
Building Height: 43.4'
Story Height: 39'
Number of stories *above* grade: 1
Number of basement stories *below* grade: 0

Year of Original Construction and Code Year: 1930, unknown
Year of Later Constuction and Code Year: not applicable

COST RANGE TO RETROFIT (if applicable): N/A

BUILDING DESCRIPTION

General
This building was built in 1930 and is situated on a level site. The building has one story and is approximately 43 feet tall. The building is rectangular in shape with a footprint of about 97 feet in the

NS direction and 77 feet in the EW direction. The building area is approximately 8200 square feet and houses the steam generation plant and miscellaneous office/storage space.

An additional wing was added in 1989 to house the cogeneration plant. A 4" seismic separation joint was incorporated between the two buildings. The roof of the Cogeneration Plant is at 23.5' and the roof of the Central Heating Plant is at 43.5'.

Structural System

The gravity load structural system consists of normal-weight concrete roof slabs on steel joists framing into steel trusses. The ground floor is a reinforced concrete slab-on-grade. The steel trusses frame into steel columns that are embedded in the reinforced concrete walls around the building. The lateral load system consists of reinforced concrete shear walls around the perimeter of the building. The roof slab serves as horizontal diaphragms. The walls and the columns are founded on spread footings.

Building Condition

Good.

Date of Site Visit: 11/08/2018, Abe Lynn, Degenkolb Engineers
Limitations of walk-through: none.

SITE INFORMATION

Site Class (A-F): D Basis: 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project which was immediately adjacent to the Central Plant.
Site Specific Ground Motion Study? Yes, 2015 Update to the Site-Specific Seismic Hazard Analyses and Development of Seismic Design Ground Motions
BSE-1N Spectral Accelerations: Basis: 2015 Site Specific Report Table 5 for 36-75 ft Soil
S_{DS}: 2.40 S_{D1}: 0.71
BSE-2E Spectral Accelerations: Basis: 2015 Site Specific Report Table 6 for 36-75 ft Soil
S_{XS}: 3.15 S_{X1}: 1.05
Level of Seismicity: High
Performance Level: Collapse Prevention Structural Performance

Geologic Hazards:
Fault Rupture No Basis: 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project and CGS website https://maps.conservation.ca.gov/cgs/informationwarehouse/regulatorymaps/
Liquefaction Low Basis: 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project and CGS website https://maps.conservation.ca.gov/cgs/informationwarehouse/regulatorymaps/
Landslide Low Basis: 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project and CGS website https://maps.conservation.ca.gov/cgs/informationwarehouse/regulatorymaps/

PREVIOUS RATINGS SUMMARY

1. Good – 1997 Preliminary Seismic Evaluation (SAFER), Forell/Elsesser Engineers

DOCUMENTATION

Architectural Drawings: Central Heating Plant, George W. Kelham, Architect, January 15, 1930, Sheet Numbers (AE Numbers) 1 and 2 of architectural set.

Structural Drawings: Central Heating Plant, H. J. Brunnier Structural Engineer, February 5, 1930, Sheet Numbers (AE Numbers) S1 through S5.

Seismic Evaluations: 1997 Preliminary Seismic Evaluation (SAFER), Forell/Elsesser Engineers, August 26, 1997, FEMA-178

Geotechnical Reports: Not available for original construction; however, 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project which was immediately adjacent to the Central Plant.

Other Documents: None

CONSTRUCTION DATA

Gravity Load Structural System:	normal-weight concrete roof slabs on steel joists framing into steel trusses. The steel trusses frame into steel columns that are embedded in the reinforced concrete walls around the building.		
Exterior Transverse Walls:	Reinforced concrete	Opening(s)?	Yes
Exterior Longitudinal Walls:	Reinforced concrete	Opening(s)?	Yes
Roof Materials/Framing:	4” reinforced concrete (normal weight) slabs on steel joists framing into steel trusses.		
Intermediate Floors/Framing:	N/A		
Ground Floor:	8” concrete slab on grade		
Columns:	8H32 and 12/8H40.5 Steel Columns	Foundation:	Spread footings
General Condition of Structure:	Good		
Evidence of Settling?:	No		
Special Features & Comments:			

LATERAL-FORCE-RESISTING SYSTEM

	Longitudinal	Transverse
ASCE 41-17 Building Type:	C2: Concrete SW	C2: Concrete SW
Diaphragms:	RC slab on steel joists	RC slab on steel joists
Vertical Elements:	Wide Flange embedded in RC walls	Wide Flange embedded in RC walls
Connections:	Riveted	Riveted
Details:	Ex: Connection Detail at Col. 17/Sheet S4	Ex: Connection Detail at Col. 17/Sheet S4
Estimated Fundamental Period, T (sec):	0.34	0.34

BSE-2E Spectral Acceleration, S_a:	3.07g	3.07g
Modification Factor, C:	1.4 (C2 – Table 4-7)	1.4 (C2 – Table 4-7)
Building Weight, W (kips):	1462	1462
Seismic Base Shear, V (kips):	6290	6290
System Modification Factor, M_s:	4.5 for reinforced concrete shear wall at CP per Table 4-8 of ASCE 41-17	4.5 for reinforced concrete shear wall at CP per Table 4-8 of ASCE 41-17

Significant Structural Deficiencies, Potentially Affecting *Seismic Performance Level* Designation:

☐ Lateral System Stress Check (wall shear, column shear or flexure, or brace axial as applicable)

☐Load Path

☐Adjacent Buildings

☐Weak Story

☐Soft Story

☐Geometry (vertical irregularities)

☐Torsion

☐Mass – Vertical Irregularity

☐Cripple Walls

☐Wood Sills (bolting)

☐Diaphragm Continuity

☐Openings at Shear Walls (concrete or masonry)

☐Liquefaction

☐Slope Failure

☐Surface Fault Rupture

☐Masonry or Concrete Wall Anchorage at Flexible Diaphragm

☐URM wall height to thickness ratio

☐URM Parapets or Cornices

☐URM Chimney

☐Heavy Partitions Braced by Ceilings

☐Appendages

OVERALL SEISMIC DEFICIENCIES & EXPECTED SEISMIC PERFORMANCE

The building is regular and symmetric in plan with a clear load path from roof to foundation.

The 4" seismic separation between the Cogeneration Plant and the Central Plant would correspond to a 1.4% total drift between the two buildings in order for contact to occur. In addition, the gravity load system is on steel columns embedded in the concrete shear walls. Both buildings are reinforced concrete shear wall buildings with significant area of wall in each direction.

There were two identified non-compliant ASCE 41-17 Tier 1 checklist items:

1. Shear Stress Check: reinforced concrete wall shear stresses were calculated to be 117 psi, which is larger than the 100 psi allowable (as a minimum). In using the Tier 1 check, only the concrete capacity is used (which is 2*roots f'c) and in order to satisfy the check, the concrete strength, f'c would need to be 3422 psi. However, there are several mitigating factors: the structure is regular, there is a clear load path, and the Tier 1 check does not include reinforcement contribution.
2. Reinforcing Steel Check: The wall reinforcement ratios are both just below the minimum required, with the vertical steel ratio = 0.0011 (minimum = 0.0012), and the horizontal steel ratio = 0.0017 (minimum = 0.0020).

Based on the above deficiencies and for the reasons defined above, the building is assigned a SPL IV rating.

The non-structural equipment was observed to be braced, either to the ground or to the structure. Adequacy of bracing/anchorage was not checked.

Seismic Retrofit Concept Sketches/Description (only if above-listed rating is V or greater):

Not applicable

Appendices

A. Additional Photos

B. ASCE 41-17 Tier 1 Checklists (Structural)

C. UCOP Seismic Safety Policy Falling Hazards Assessment Summary

D. Quick Check Calculations

APPENDIX A

Additional Photos

Figure A.1 East Elevation of Central Plant (Central Heating Plant is building to right)

Figure A.2 East and North Elevations of Central Heating Plant

Figure A.3 Raised Roof Structure of Central Heating Plant

Figure A.4 Interior of Raised Roof Structure of Central Heating Plant

Figure A.5 Roof Truss at Intersection with Exterior Wall (note riveted connections typical of the steel framing throughout)

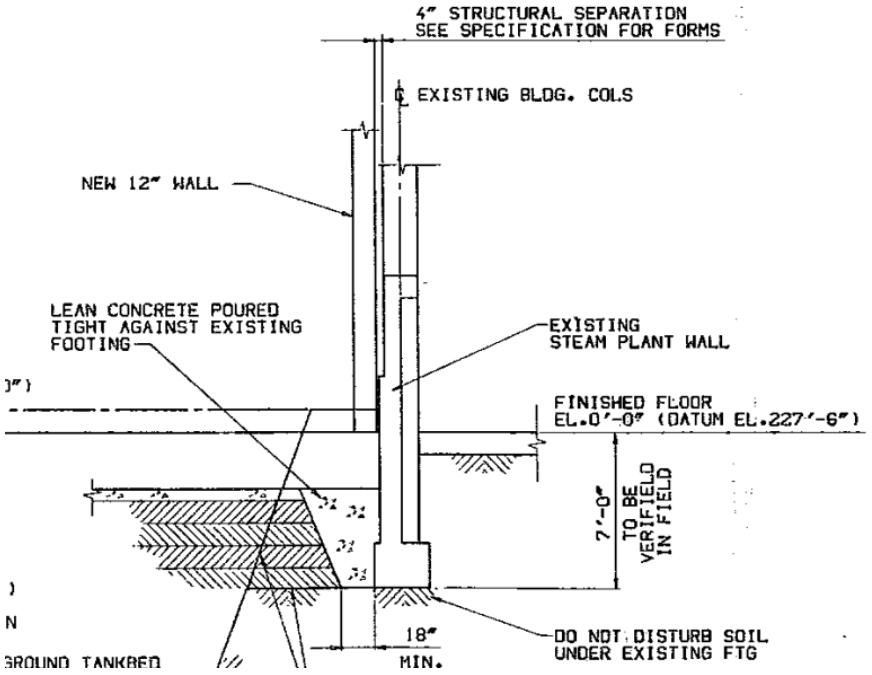

Figure A.6 Section Showing 4" Seismic Separation Between Central Heating Plant and Cogeneration Plant

APPENDIX B

ASCE 41-17 Tier 1 Checklists (Structural)

UC Campus:	Berkeley			Date:	December 21, 2018	
Building CAAN:	1374	Auxiliary CAAN:		By Firm:	Degenkolb	
Building Name:	1930 Central Heating Plant			Initials:	ACL	Checked:
Building Address:	Cross Campus Road			Page:	1	of 3

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

Low And Moderate Seismicity

Seismic-Force-Resisting System

	Description
C NC N/A U ● ○ ○ ○	COMPLETE FRAMES: Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system. (Commentary: Sec. A.3.1.6.1. Tier 2: Sec. 5.5.2.5.1) **Comments:**
C NC N/A U ● ○ ○ ○	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1) **Comments:**
C NC N/A U ● ○ ○ ○	SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the greater of 100 lb/in.^{2} (0.69 MPa) or $2\sqrt{f'_c}$. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1) **Comments:** Shear stress calculates out to 117 psi. To satisfy Tier 1 stress check, concrete strength, f'c would need to be 3422 psi.
C NC N/A U ● ○ ○ ○	REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. (Commentary: Sec. A.3.2.2.2. Tier 2: Sec. 5.5.3.1.3) **Comments:** Walls calculate out a vertical steel ratio of 0.0011 and a horizontal ratio of 0.0017.

Connections

	Description
C NC N/A U ○ ○ ● ○	WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS: Exterior concrete or masonry walls that are dependent on flexible diaphragms for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1) **Comments:**
C NC N/A U ● ○ ○ ○	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2) **Comments:**

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

C	NC	N/A	U	
●	○	○	○	FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation with vertical bars equal in size and spacing to the vertical wall reinforcing directly above the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4) **Comments:**

High Seismicity (Complete The Following Items In Addition To The Items For Low And Moderate Seismicity)

Seismic-Force-Resisting System

				Description
C	NC	N/A	U	
●	○	○	○	DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2) **Comments:**
○	○	●	○	FLAT SLABS: Flat slabs or plates not part of the seismic-force-resisting system have continuous bottom steel through the column joints. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3) **Comments:**
○	○	●	○	COUPLING BEAMS: The ends of both walls to which the coupling beam is attached are supported at each end to resist vertical loads caused by overturning. (Commentary: Sec. A.3.2.2.3. Tier 2: Sec. 5.5.3.2.1) **Comments:**

Diaphragms (Stiff Or Flexible)

				Description
C	NC	N/A	U	
○	●	○	○	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1) **Comments:** The popout roof at the center of the roof has a continuous load path in each direction: shear walls in the North-South and cantilever beams in the East-West.
●	○	○	○	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3) **Comments:**

UC Campus:	Berkeley			Date:	December 21, 2018	
Building CAAN:	1374	Auxiliary CAAN:		By Firm:	Degenkolb	
Building Name:	1930 Central Heating Plant			Initials:	ACL	Checked:
Building Address:	Cross Campus Road			Page:	1	of 3

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

Low And Moderate Seismicity

Seismic-Force-Resisting System

	Description
C NC N/A U ● ○ ○ ○	COMPLETE FRAMES: Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system. (Commentary: Sec. A.3.1.6.1. Tier 2: Sec. 5.5.2.5.1) **Comments:**
C NC N/A U ● ○ ○ ○	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1) **Comments:**
C NC N/A U ○ ● ○ ○	SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the greater of 100 lb/in.^{2} (0.69 MPa) or $2\sqrt{f'_c}$. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1) **Comments:** Shear stress calculates out to 117 psi. To satisfy Tier 1 stress check, concrete strength, f'c would need to be 3422 psi.
C NC N/A U ○ ● ○ ○	REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. (Commentary: Sec. A.3.2.2.2. Tier 2: Sec. 5.5.3.1.3) **Comments:** Walls calculate out a vertical steel ratio of 0.0011 and a horizontal ratio of 0.0017.

Connections

	Description
C NC N/A U ○ ○ ● ○	WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS: Exterior concrete or masonry walls that are dependent on flexible diaphragms for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1) **Comments:**
C NC N/A U ● ○ ○ ○	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2) **Comments:**

APPENDIX C

UCOP Seismic Safety Policy Falling Hazards Assessment Summary

UC Campus:	Berkeley			Date:	12/27/2018		
Building CAAN:	1374	Auxiliary CAAN:	N/A	By Firm:	Degenkolb Engineers		
Building Name:	Central Heating Plant			Initials:	ACL	Checked:	
Building Address:	209 Frank Schlessinger Way, Berkeley, CA			Page:	1	of	1

UCOP SEISMIC SAFETY POLICY
Falling Hazard Assessment Summary

	Description
P ☐ N/A ☒	**Heavy ceilings, features or ornamentation above large lecture halls, auditoriums, lobbies, or other areas where large numbers of people congregate (50 ppl or more)** **Comments:**
P ☐ N/A ☒	**Heavy masonry or stone veneer above exit ways or public access areas** **Comments:**
P ☐ N/A ☒	**Unbraced masonry parapets, cornices, or other ornamentation above exit ways or public access areas** **Comments:**
P ☐ N/A ☒	**Unrestrained hazardous material storage** **Comments:**
P ☐ N/A ☒	**Masonry chimneys** **Comments:**
P ☐ N/A ☒	**Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**

Note: P= Present, N/A = Not Applicable

APPENDIX D

Quick Check Calculations

Degenkolb

Subject:	ASCE 41 Shear Stress check, Section 4.4.3.3		**Job Number:**	B8114004.00	**Date:** 12/26/18
Job:	UCB Seismic Eval, Central Heating Plant		**By:**	ACL	**Section:**
Model:	ASCE 41, TIER 1		**Checked By:**		**Page** **of**

Lwall =	996	in	
twall =	12	in	
Ms =	4.5	for RC wall, Collapse Prevention	
Aw =	11952		
f'c =	2000	psi	(assumed)
2*sqrt(f'c) =	89	psi	
vj-avg =	117	psi	

Degenkolb

Subject:	ASCE 41 Reinforcing Steel check		**Job Number:**	B8114004.00	**Date:** 12/26/18
Job:	UCB Seismic Eval, Central Heating Plant		**By:**	ACL	**Section:**
Model:	ASCE 41, TIER 1		**Checked By:**		**Page** **of**

1/2" diameter bars at 18" o.c.

Vertical:		
twall =	10	in
Abar =	0.2	in2
spacing =	18	in
rho =	0.0011	No Good
Horizontal:		
twall =	10	in
Abar =	0.2	in2
spacing =	12	in
rho =	0.0017	No Good

Degenkolb Engineers
1300 Clay St, 9th Floor
Oakland, CA 94612-2047
Phone: 510.272.9040
Fax: 510.272.9526

Subject:	Weight Take Off	**Job Number:**	B8114004.00	**Date:**	12/27/2018
Job:	1930 Central Heating Plant	**By:**	ACL	**Section:**	
		Checked By:		**Page/of:**	

Roof

	Area (ft2)	Thickness (in)	Weight (pcf)		Flat Load (psf)
Slab	7420.5	4	150		50.0
(includes raised roof)	Width	Depth (less slab)	Weight (pcf)	Spacing (in, typ)	Convert to Flat Load (psf)
Joists	10	12.5	150	95	16.4
	PLF			Spacing (in, typ)	Convert to Flat Load (psf)
14B30	30			95	3.8
	PLF			Spacing (in, typ)	Convert to Flat Load (psf)
Trusses	66			303	2.6
	Area (ft2)				
Openings	122				

	Number of columns	Height (ft)	Weight (plf)	Weight (lbs)	Convert to Flat Load (psf)
Interior Column (4)14H84	4	43	84	14448	1.9

	Thickness (in)	Length (ft)	Height (ft)	Weight (pcf)	Weight (lbs)	Convert to Flat Load (psf)
Exterior concrete walls	12	347	43.33	150	1886252	254
	Openings	2461	Area (ft2)			

Total Flat Load: (Slab + Joists)*(Area - Open)+Girder+Wall+ Col	1462	kips
Effective Flat Dead Load (includes 10psf Partition)	335	psf

Total building weight 1462 kips