HCAI/CSMIP

HOSPITAL INSTRUMENTATION

Annual Report

July 1, 2023 through June 30, 2024

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California Strong Motion Instrumentation Program
California Department of Conservation
California Geological Survey

715 P Street, MS 1901
Sacramento, California 95814

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I. INTRODUCTION

The California Geological Survey's Strong Motion Instrumentation Program (CSMIP) of the Department of Conservation, performs installation, maintenance, and data recovery for strong motion instrumentation in hospitals through an interagency agreement with the Department of Health Care Access and Information (HCAI). Funding strong motion instrumentation of hospitals through the interagency agreement is in lieu of normal building-permit fee funding referenced in Chapter 8 of the Public Resources Code.

Hospital buildings have been instrumented under twelve Interagency Agreements. The first eleven agreements extended from July 1989 through June 2023, each covering a period of three fiscal years. The twelfth contract was approved by the Department of General Services (DGS) on September 5, 2023. This Report covers activities performed between July 1, 2023 and June 30, 2024 (FY23-24).

The code requirements regarding the instrumentation of hospitals were updated in 2019. Previously, the code stipulated that HCAI was responsible for subsidizing the maintenance of instrumentation installed at hospitals. With the updated requirements, however, the code requires hospital owners to pay for maintenance. When a maintenance issue is identified, CSMIP reports it to HCAI, then either HCAI authorizes CSMIP to perform the work, or advises the hospital owner that they are responsible for maintenance. If CSMIP performs maintenance on instrumentation that the hospital owner has responsibility for, the hospital owner can be billed to recover the cost of the work performed.

During FY23-24, the Hospital Building Safety Board (HBSB) Instrumentation Committee recommended seven one-story wood-framed hospitals for instrumentation, with funding to be provided by HCAI. HCAI has started coordinating with the representatives at these hospitals on the details of the project. In addition, there was progress on various owner-funded hospital instrumentation projects as CSMIP marked sensor locations at two hospitals and continued to provide technical guidance and assistance to the general contractors and structural engineers on other instrumentation projects currently underway.

In addition to new instrumentation projects under the CGS/HCAI agreement, CSMIP upgraded the recorders at twenty stations (hospital buildings and free-fields) with existing instrumentation at no charge for equipment to HCAI. The instrumentation at these stations was upgraded from obsolete recording systems to modern higher resolution recorders capable of real-time data

streaming. The funding for these upgrades was provided by CGS through its Statewide Seismic Hazard Mitigation BCP Upgrade Project. So far, CSMIP has upgraded 34 hospitals and free-field stations as part of the Statewide Seismic Hazard Mitigation project.

II. HOSPITAL INSTRUMENTATION STATUS

Hospital buildings with instrumentation underway are listed in Tables 1, 2, and 3. Like the other hospitals recently instrumented by the CSMIP, the new stations will have near-real-time data communication capability to allow the recorded motion to be automatically transmitted to the CSMIP servers after an earthquake where it will be automatically processed and made available for use in post-earthquake response by the HCAI and the hospital owners.

1) Type 1 - HCAI-Funded Regular Instrumentation of Hospitals (Table 1)

During FY23-24 the Hospital Building Safety Board (HBSB) Instrumentation Committee recommended seven one-story wood-framed hospitals for instrumentation, with funding to be provided by HCAI. HCAI has started coordinating with the representatives at these hospitals. Four of the hospitals have provided plans and other information to HCAI which are being used to develop preliminary instrumentation layouts. CSMIP and HCAI met on March 12, 2024 to review project details.

2) Types 2 and 3 - Owner-Funded Instrumentation of Hospitals with CSMIP Guidance and Assistance (Tables 2 and 3)

In addition to the hospital instrumentation funded under the HCAI/CSMIP contract discussed above, a significant component of CSMIP hospital instrumentation work involves detailed technical guidance and assistance with hospital instrumentation projects for which the owner absorbs the capital cost of instrumentation under HCAI regulations. These may be in new hospitals (Type 2), or in existing hospitals being retrofitted (Type 3). Nine CSMIP-assisted hospital instrumentation projects are currently underway.

Background on Instrumentation Guidance

CSMIP guidance and assistance in the instrumentation of hospitals includes the following steps:

1. Development or review of the proposed sensor locations to ensure sensor coverage is sufficient to characterize the building's seismic response. CSMIP performs design work in-house, or reviews plans and specifications submitted by the design structural engineer of record (SE). In either case, an instrumentation planning meeting or conference call among the SE, architect of record, HCAI and CSMIP staff is held to discuss and develop consensus on sensor locations and quantity.
2. Establishment of the specific locations of all sensors, based on detailed study of the architectural plans by the design architect or SE. Sensor locations need to avoid conflict with other non-structural components and sensors need to be accessible after they are installed.
3. Development of the comprehensive, detailed design of the system, called the Technical Specifications Letter (TSL), by CSMIP staff. The TSL is provided to the owner, HCAI,

and the contractor, and is included in the plans. It specifies acceptable instruments and approved installation practices as well as details for the locations and interconnection of the components. The final instrumentation plans are approved by HCAI.

4. Sensor marking field visit by CSMIP staff with representatives of the owner, construction contractor and HCAI Inspector of Record. During this visit the actual sensor locations are approved and physically marked on the structural members. During the subsequent work by the contractor, CSMIP staff approves the submittals, assists with problems and issues as they arise.
5. Acceptance field testing of the completed instrumentation system, some months or years later, by CSMIP staff. If problems are found in the installation or operation, the contractor is called back in for repairs, followed by a repeat of tests. Once the installed system is accepted, HCAI is notified, and CSMIP is supported by HCAI to take on long-term maintenance of the instrumentation, as well as data recovery and processing.
6. CSMIP staff prepare sensor location diagram, building descriptions and station photo for the building, which are made available at the Center for Engineering Strong Motion Data (CESMD) after the instrumentation is completed.

Type 2 Instrumentation Projects

These hospital buildings have base-isolation and/or energy dissipation devices or use an Alternate Method of Compliance (AMOC) in their design. These are required to have owner-paid instrumentation installed during construction per the California Building Code and HCAI regulations. The following progress on Type 2 projects occurred during FY23-24.

- Cedars-Sinai Medical Center Replacement Hospital in Marina Del Rey: Sensor locations were marked on April 3, 2024.
- UC Irvine Medical Center New Hospital: Sensor locations were marked on November 30, 2023.
- UC Davis Health New Hospital in Sacramento: The Technical Specifications Letter was completed and sent to the design team on June 19, 2024. The sensor marking visit for this project is not anticipated until FY29-30.
- Harbor UCLA Medical Center in Torrance: An instrumentation planning meeting was held on November 14, 2023. The Technical Specifications Letter was completed and sent to the design team on March 21, 2024.
- University Medical Center Replacement Hospital in Loma Linda: The relative displacement sensors at the base of the hospital still need to be installed, which is anticipated to occur during FY24-25. The hospital owner is required to provide brackets and straps for the relative displacement sensors before they can be installed.
- Hollywood Presbyterian Medical Center Acute Care Services Replacement Building in Los Angeles: The contractor is coordinating the installation of the sensors with the equipment manufacturer; the acceptance of the instrumentation is anticipated to occur during FY24-25.

Type 3 Instrumentation Projects

These buildings are retrofitted under the Voluntary Seismic Improvement (VSI) regulations of the hospital building design code. Because of an AMOC design used in their retrofit, these buildings are required to be instrumented at the owner's expense. There are no Type 3 hospital instrumentation projects underway in the current interagency agreement.

Table 1

Regular Hospital Buildings (Type 1)
Instrumented under HCAI/CSMIP Hospital Instrumentation Project

(HCAI Funded - HBSB Instrumentation Committee Recommended)

Hospital Name	CSMIP Sta. No.	HCAI Approval No.	Year Built	No. of Stories	No. of Sensors	Completion Date
Instrumentation Completed or Underway						
1. Fortuna – Providence Redwood Memorial Hospital						
	89nnn	--	1955	1/0	24	FY 24-25
	Wood shear wall					
	[**STATUS:** Hospital representative provided plans to HCAI; Instrumentation layout underway]					
2. Healdsburg – Healdsburg Hospital						
	68nnn	--	1972	1/0	12	FY 24-25
	Wood shear wall					
	[**STATUS:** Hospital representative provided plans to HCAI; Instrumentation layout underway]					
3. Santa Rosa – Providence Santa Rosa Memorial Hospital						
	68nnn	--	1961	1/0	16	FY 24-25
	Wood shear wall					
	[**STATUS**: Hospital representative provided plans to HCAI; Instrumentation layout underway]					
4. Hollister – Hazel Hawkins Memorial Hospital						
	47nnn	--	1960	1/0	9	FY 24-25
	Wood shear wall					
	[**STATUS**: Hospital representative provided plans to HCAI; Instrumentation layout underway]					
5. Ojai – Community Memorial Hospital						
	25nnn	--	1960	1/0	TBD	FY 25-26
	Wood shear wall					
	[**STATUS**: HCAI establishing contact with hospital representative]					
6. Monterey Park – Monterey Park Hospital						
	24nnn	--	1971	1/0	TBD	FY 25-26
	Wood shear wall					
	[**STATUS**: HCAI establishing contact with hospital representative]					
7. San Bernardino – Community Hospital						
	23nnn	--	1969	1/0	TBD	FY 25-26
	Wood shear wall					
	[**STATUS**: HCAI establishing contact with hospital representative]					

Table 2

New Hospital Buildings (Type 2) – Assisted Instrumentation Base-Isolated or Alternate Method of Compliance

(Owner-Funded with CSMIP Assistance and Guidance)

Hospital Name	CSMIP Sta. No.	HCAI Approval No.	Year Built	No. of Stories	No. of Sensors	Completion Date

Instrumentation Completed or Underway

1. Loma Linda – University Medical Center Replacement Hospital

23M01 | I 150010-36 | ca 2021 | 16/2 | 42+FF | FY 24-25

Steel BRB and SidePlate moment frames isolated with triple pendulum bearings and viscous dampers.

[**STATUS:** TSL completed 4/26/17; Sensor locations marked 9/6/2018, 4/11/2019 and 1/30/2020; Accelerometers installed 10/21/2020]; Relative Displacement sensors to be installed.

Reference free-field station: Loma Linda – Barton & Anderson, CSMIP Sta. 23702

2. Los Angeles - Hollywood Presbyterian Medical Center Acute Care Services Replacement Building

24758 | I 17002-19-02 | ca 2025 | 4/1 | 16 | FY 24-25

Steel moment frames with SidePlate connections

[**STATUS:** TSL completed 10/26/17; Sensor locations marked 5/6/2020]

(Pre-existing reference FF station: Los Angeles – Vermont & Fountain, CSMIP Sta. 24642)

3. Marina Del Rey – Cedars-Sinai Medical Center Replacement Hospital

14756 | I 180008-19-00 | ca 2025 | 9/0 | 24+FF | FY 24-25

Steel moment frames with SidePlate connections.

[**STATUS:** TSL completed 7/16/21; Sensor locations marked 4/3/2024]

(To include a reference free-field station)

4. La Jolla – Scripps Tower II

03754 | I 190018-37-00 | ca 2025 | 8/1 | 18 | FY 24-25

Steel moment frames with bolted SidePlate connections

[**STATUS:** TSL completed 2/8/22; Sensor locations marked 6/28/2023]

(Pre-existing reference FF station: La Jolla – I5 & Genesee**,** CSMIP Sta. 03539)

5. San Diego – Sharp Metropolitan Medical Center New Tower

03755 | I 210010-37-01 | ca 2030 | 7/0 | 18+FF | FY 29-30

Steel moment frames with bolted SidePlate connections.

[**STATUS:** TSL completed 5/31/22]

(To include a reference free-field station)

6. Irvine – UC Irvine Medical Center New Hospital

13751 | I 210005-30-03 | ca 2025 | 7/0 | 15+FF | FY 24-25

Steel buckling restrained braced frames

[**STATUS:** TSL completed 3/9/23; Sensor locations marked 11/30/2023]

(To include a reference free-field station)

7. Sacramento – UC Davis Health New Hospital

67759 | I 210013-34-05 | ca 2030 | 14/1 | 47+FF | FY 29-30

Steel moment frames with SidePlate connections.

[**STATUS:** Kickoff meeting with design team held 1/30/23; TSL completed 6/19/24]

(To include a reference free-field station)

Table 2 (continued)

New Hospital Buildings (Type 2) – Assisted Instrumentation Base-Isolated or Alternate Method of Compliance

(Owner-Funded with CSMIP Assistance and Guidance)

Hospital Name	CSMIP Sta. No.	HCAI Approval No.	Year Built	No. of Stories	No. of Sensors	Completion Date
8. Torrance – Harbor UCLA Medical Center						
	14757	I 230003-19-03	ca 2028	9/1	23+FF	FY 27-28
	Steel moment frames with SidePlate connections. [**STATUS:** Instrumentation planning meeting held 11/14/23; TSL completed 3/21/24] (To include a reference free-field station)					
9. San Jose – Kaiser Replacement Hospital						
	57nnn	I 230010-43	ca 2028	6/1	28+FF	FY 27-28
	Steel moment frames with SidePlate connections. [**STATUS:** Instrumentation planning meeting to be scheduled] (To include a reference free-field station)					

Table 3

Existing Hospital Buildings (Type 3) – Assisted Instrumentation Voluntary Seismic Improvement (VSI) Projects

(Owner-Funded with CSMIP Assistance and Guidance)

Hospital Name	CSMIP Sta. No.	HCAI Approval No.	Year Design	No. of Stories	No. of Sensors	Installation Date

**No Type 3 projects currently underway*

III. HOSPITAL INSTRUMENTATION MAINTENANCE

In this section, the previously instrumented hospital buildings for which ongoing maintenance was performed throughout FY23-24 are listed. During FY23-24, CSMIP performed periodic maintenance of the strong-motion instrumentation installed in the 85 previously instrumented hospital buildings, 66 of which have an associated free-field instrument.

The 85 hospital buildings instrumented as of the beginning of FY23-24 (buildings with an associated reference free-field station are indicated by an *), are listed alphabetically by city below:

1. Alameda - Alameda Hospital *
2. Bakersfield - Kern County Hospital *
3. Berkeley - Alta Bates Hospital
4. Burlingame - Mills Peninsula Hospital *
5. Castro Valley - Sutter Eden Medical Center *
6. Colton - Arrowhead Regional Medical Center (base-isolated) *
7. Crescent City - Sutter Coast Hospital *
8. Downey - Kaiser Hospital Tower Expansion *
9. Downey - PIH Health Medical Center (VSI) *
10. El Centro - El Centro Regional Medical Center *
11. Encino - Encino Hospital (VSI) *
12. Escondido - Palomar West Medical Center, Central Plant
13. Escondido - Palomar West Medical Center, Main Tower *
14. Eureka - St. Joseph Hospital *
15. Fairfield - North Bay Medical Center *
16. Fremont - Kaiser Hospital *
17. Fremont - Washington Hospital (base isolated) *
18. Gilroy - St. Louise Hospital *
19. Greenbrae - Marin General Hospital Replacement Building *
20. Hemet - Hemet Valley Medical Center *
21. Indio - JFK Memorial Hospital *
22. Irvine - Kaiser Sand Canyon Hospital *
23. King City - Mee Hospital *
24. La Jolla - Scripps Memorial Hospital (VSI) *
25. La Jolla - UCSD Hospital *
26. La Jolla - UCSD Jacobs Medical Center
27. Lancaster - Antelope Valley Hospital *
28. Long Beach - Miller Children's Hospital *
29. Los Angeles - Children's Hospital
30. Los Angeles - Good Samaritan Hospital
31. Los Angeles - Hollywood Presbyterian Medical Center, Doctor's Tower (VSI)
32. Los Angeles - Hollywood Presbyterian Medical Center, South Wing (VSI) *
33. Los Angeles - LAC+USC Hospital D&T (base-isolated) *
34. Los Angeles - LAC+USC Hospital Inpatient Bldg
35. Los Angeles - MLK Hospital (base-isolated) *
36. Los Angeles - USC Hospital (base-isolated)
37. Los Angeles - USC Hospital Addition

38. Mammoth Lakes - Mammoth Hospital *
39. Moreno Valley - Riverside County Hospital *
40. Murrieta - Rancho Springs Medical Center *
41. Newport Beach - Hoag Hospital West Tower *
42. Newport Beach - Hoag Hospital East Tower (base-isolated)
43. Novato - Community Hospital *
44. Oakland - Kaiser Hospital
45. Ontario - Kaiser Hospital *
46. Oxnard - St. John's Medical Center *
47. Palm Springs - Desert Hospital
48. Palmdale - Palmdale Regional Medical Center *
49. Palo Alto - Lucile Packard Children's Hospital Stanford *
50. Redlands - Community Hospital (VSI) *
51. Riverside - Community Hospital (VSI) *
52. Salinas - Natividad Medical Center *
53. San Bernardino - Community Hospital *
54. San Bernardino - St. Bernardine Hospital (VSI) *
55. San Diego - Sharp Memorial Hospital (VSI) *
56. San Diego - UCSD Medical Center *
57. San Francisco - CPMC Cathedral Hill Hospital
58. San Francisco - General Hospital (base-isolated) *
59. San Francisco - Kaiser Hospital
60. San Francisco - St. Luke's Hospital
61. San Francisco - UCSF Hospital *
62. San Francisco - UCSF Mission Bay Hospital *
63. San Jose - O'Connor Hospital *
64. San Jose - Santa Clara Valley Hospital Bed Bldg 1
65. San Jose - Santa Clara Valley Hospital Bldg K
66. San Pedro - Providence LCOM Medical Center Bldg 1T (VSI) *
67. San Pedro - Providence LCOM Medical Center Bldg 2 (VSI)
68. San Rafael - Marin General Hospital West Wing *
69. Santa Ana - Orange County Global Med Center (VSI) *
70. Santa Barbara - Cottage Hospital *
71. Santa Clara - Kaiser Hospital *
72. Santa Maria - Marian Hospital *
73. Santa Monica - St. John's Hospital (base-isolated) *
74. Santa Rosa - Kaiser Hospital *
75. Simi Valley - Simi Valley Hospital *
76. Stanford - 7-story Hospital (base-isolated) *
77. Stanford - University Hospital *
78. Sylmar - Olive View Hospital *
79. Templeton - Twin Cities Hospital *
80. Torrance - Providence LCOM Medical Center (VSI)*
81. Valencia - Mayo Hospital *
82. Ventura - Community Memorial Hospital *
83. Ventura - Ventura County Hospital *
84. Walnut Creek - Kaiser Hospital
85. Whittier - Presbyterian Intercommunity Hospital *

In addition to periodic maintenance, CSMIP upgraded the recorders, without charge to HCAI, at the following twenty hospitals and free-field stations in FY 23-24. The instrumentation at these stations was upgraded from obsolete recording systems to modern higher resolution recorders capable of real-time data streaming. The funding for these upgrades was provided by CSMIP through its Statewide Seismic Hazard Mitigation BCP Upgrade Project. A total of 34 hospital and free-field stations have now been upgraded as part of this project, without charge for equipment to HCAI.

1. Colton – San Bernardino County Medical Center
2. Crescent City – Sutter Hospital
3. Crescent City – Sutter Hospital Grounds
4. Eureka – St. Joseph Hospital
5. Gilroy – St. Louise Hospital
6. Los Angeles – Childrens Hospital
7. Los Angeles – LAC+USC Hospital IP Building
8. Los Angeles – MLK Hospital
9. Palm Springs – Desert Hospital
10. Salinas – Natividad Medical Center
11. San Diego – UCSD Hospital
12. San Rafael – Marin General Hospital
13. San Rafael – Marin Hospital Grounds
14. Santa Barbara – Cottage Hospital Free-Field
15. Santa Clara – Homestead & Lawrence Expressway
16. Santa Clara – Kaiser Hospital
17. Simi Valley – Simi Valley Hospital
18. Simi Valley – Simi Valley Hospital Grounds
19. Stanford – University Hospital
20. Sylmar – Olive View Hospital Grounds

CSMIP also performs monitoring and data recovery for the code-type instrumentation systems (three tri-axial accelerographs) in the following four hospitals without charge to HCAI:

1. Los Angeles – White Memorial Hospital (7-story)
2. Pasadena – Huntington Memorial Hospital (7-story)
3. Downey – Kaiser Hospital (6-story)
4. Los Angeles – Kaiser LAMC Sunset Hospital (7-story)

IV. STRONG-MOTION RECORDS FROM HOSPITALS

From July 1, 2023 to June 30, 2024 a total of 18 earthquakes with magnitude 3.0 or larger were recorded at 24 instrumented hospitals. The earthquake information, including the maximum accelerations recorded at the hospital buildings (base and superstructure) and at their reference free-field stations (ground), are listed below for these cases.

Station 89770: Eureka – St Joseph Hospital (4-story concrete shear walls)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
McKinleyville	3.8	8/13/23	21.1	1.5	1.3	3.4
Ferndale	4.7	9/30/23	27.9	1.9	1.8	7.1
Petrolia	4.7	10/16/23	52.5	1.6	1.0	3.3
Humboldt Hill	4.0	10/16/23	31.1	--	0.5	2.0

* Station 89781

Station 58199: Walnut Creek – Kaiser Hospital (3-story steel moment frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground	Base	Structure
Alamo	3.4	8/15/23	3.0	--	0.7	2.0
Isleton	4.2	10/18/23	44.9	--	0.3	1.2

Station 24104: Simi Valley – Simi Valley Hospital (2-story steel moment frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Ojai	5.0	8/20/23	42.6	2.3	2.2	8.7
Malibu	4.6	2/9/24	29.7	2.2	1.3	3.8

* Station 24126

Station 24202: Santa Monica – St John's Hospital (5-story, isolated, concentrically braced steel frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground	Base	Structure
Ojai	5.0	8/20/23	77.5	--	0.6	1.2

Station 24344: Valencia – Mayo Hospital (2-story concentrically braced steel frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Ojai	5.0	8/20/23	57.9	--	0.7	2.2
Malibu	4.6	2/9/24	49.9	--	0.7	1.7

* Station 24354

Station 24514: Sylmar – Olive View Medical Center (6-story concrete/steel shear wall)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Ojai	5.0	8/20/23	68.5	0.8	0.7	2.1

* Station 24763

Station 24M01: Pasadena – Huntington Memorial Hospital (7-story)

Earthquake	Magnitude		Epicentral Distance (km)	Max. Horizontal Acceleration (%g)

		Date		Groun	Base	Structure
Ojai	5.0	8/20/23	99.6	--	0.2	1.3
Lamont	5.2	8/7/24	138.5	--	0.5	--

Station 25594: Ventura – Community Memorial Hospital (6-story concentrically braced steel frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Ojai	5.0	8/20/23	17.0	12.0	5.2	9.7

* Station 25596

Station 25744: Ventura – County Hospital (4-story concrete shear wall)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Ojai	5.0	8/20/23	16.5	--	11.9	35.3

* Station 25747

Station 25949: Oxnard – St John's Hospital (4-story steel moment frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Ojai	5.0	8/20/23	22.1	1.8	1.7	7.3

* Station 25969

Station 58390: Burlingame – Mills Peninsula Hospital (6-story, isolated, concentrically braced steel frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Millbrae	3.7	10/28/23	2.9	2.8	2.7	4.5

* Station 58395

Station 58572: San Francisco – University Hospital (6-story, buckling-restrained steel braced frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Millbrae	3.7	10/28/23	16.6	--	1.0	2.2

* Station 58579

Station 58649: San Francisco – UCSF Mission Bay Hospital (6-story buckling-restrained steel braced frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground	Base	Structure
Millbrae	3.7	10/28/23	15.0	--	3.5	4.5

Station 13213: Moreno Valley – Riverside County Hospital (3-story steel moment frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground	Base	Structure
Lytle Creek	4.2	1/5/24	48.0	1.3	0.8	1.4

Station 13633: Riverside – Community Hospital (6-story concrete shear wall)

Earthquake	Magnitude		Epicentral Distance (km)	Max. Horizontal Acceleration (%g)

		Date		Ground*	Base	Structure
Lytle Creek	4.2	1/5/24	34.2	--	1.3	7.9
San Bernardino	4.2	1/25/24	16.4	3.9	1.4	4.1

* Station 13635

Station 23788: Colton – San Bernardino Co. Medical Center (3-story, isolated, concentrically braced steel frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground	Base	Structure
Lytle Creek	4.2	1/5/24	25.1	6.2	4.8	3.1
San Bernardino	4.2	1/25/24	5.6	8.3	5.2	2.5

Station 23548: Redlands – Community Hospital (2-story concrete shear wall)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Accation (%g)		
				Ground*	Base	Structure
San Bernardino	4.2	1/25/24	12.9	2.4	2.0	3.3

* Station 23547

Station 23634: San Bernardino – Community Hospital (5-story steel moment frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
San Bernardino	4.2	1/25/24	2.4	12.7	7.3	11.3

* Station 23656

Station 23697: San Bernardino – St. Bernardine Medical Center (6-story concentrically braced steel frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
San Bernardino	4.2	1/25/24	4.0	8.0	9.4	8.0

* Station 23727

Station 14529: Torrance – Providence LCOM Hospital (4-story concrete shear wall)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Malibu	4.6	2/9/24	56.4	1.1	0.7	2.7

* Station 14530

Station 01699: El Centro – Community Hospital (1-story concrete wall and braced frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
El Centro	4.8	2/12/24	3.7	8.5	15.0	32.2
El Centro	4.6	2/12/24	2.1	5.4	6.3	20.7

* Station 01711

Station 13439: Irvine – Kaiser Sand Canyon Hospital (6-story buckling-restrained steel braced frame)

Earthquake	Magnitude		Epicentral Distance (km)	Max. Horizontal Acceleration (%g)

		Date		Ground*	Base	Structure
Corona	4.1	5/1/24	20.7	--	1.6	2.0

* Station 13441

Station 57301: Fremont – Kaiser Hospital (2-story steel moment frame)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground*	Base	Structure
Alum Rock	3.4	6/2/24	22.7	--	0.4	1.5

* Station 57311

Station 13291: Newport Beach – Hoag Hospital East Tower (7-story, isolated, steel frame and concrete shear wall)

Earthquake	Magnitude	Date	Epicentral Distance (km)	Max. Horizontal Acceleration (%g)		
				Ground	Base	Structure
Newport Beach	3.6	6/6/24	1.9	--	4.1	5.9

The strong-motion records are made available rapidly after an earthquake by the CSMIP Strong-motion Automated Recovery and Analysis (SARA) system, and posted in the Internet Quick Reports at the web site of the Center for Engineering Strong Motion Data (CESMD), at **https://www.strongmotioncenter.org**.

While the largest earthquake recorded by an instrumented hospital during FY23-24 was the M5.2 Lamont earthquake on August 7, 2024, the largest acceleration recorded inside a hospital was from the M5.0 Ojai earthquake on August 20, 2023. This earthquake was recorded by seven hospital stations, with epicentral distances ranging from 16 to 100 km. The largest structural acceleration response from this earthquake was 0.35g, recorded at Ventura County Hospital (Station 25744), located 16.5 km from the epicenter (the closest hospital station to the earthquake source). This acceleration was measured at the top of the Machine Room in the building's Elevator Tower. Considering the peak acceleration of 0.07g recorded at the building's first floor in the same direction, the level of amplification was nearly 5 times at the elevator tower. The accelerations recorded at each instrumented level of the building during this earthquake are plotted in Figure 1.

The Ventura County Hospital building is a four-story reinforced concrete structure. The lateral force-resisting system consists of 10-inch and 16-inch thick reinforced concrete shear walls along the building's perimeter, with flat concrete slabs serving as the horizontal diaphragm. The building is equipped with 12 accelerometers located at the base and upper floor levels. There is also a nearby free-field site that is abandoned (Station 25747).

Other notable records from FY23-24 include those from the Regional Hospital in El Centro during the M4.8 and M4.6 El Centro earthquakes on February 12, 2024. Due to the very small epicentral distance of approximately 3 km, the maximum accelerations recorded at this building reached 0.32g and 0.2g, respectively. The recorded acceleration signals for these two events are shown in Figures 2 and 3, respectively.

V. Real Time Strong Motion Data Stream

In response to the HCAI request, CSMIP started a pilot project on streaming data in real time to the HCAI Earthworm system. Currently data from Santa Rosa Kaiser Hospital and Lancaster Antelope Valley Hospital are being streamed in real time.

VI. FISCAL REPORT

The current contract was executed on September 5, 2023. A summary of the budget and expenditures is provided below:

Total amount of Agreement (September 5, 2023 – June 30, 2026)		$1,470,963.00
1)	Budgeted for FY23-24	$490,321.00
	Expended in FY23-24	($192,995.32)
	Remaining amount from FY23-24	$297,325.68

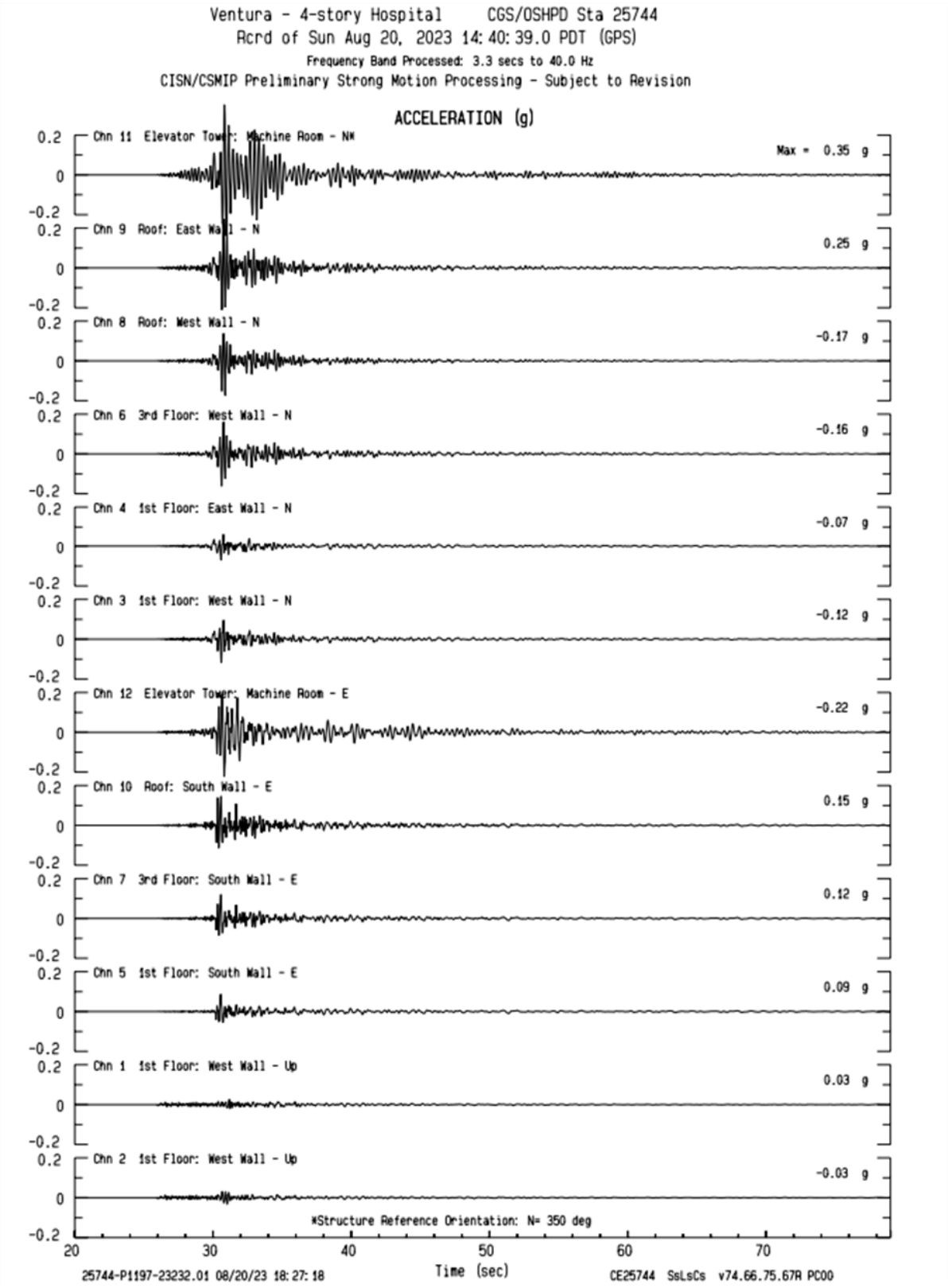


Figure 1. Accelerations recorded at the Ventura County Hospital during the M5.0 Ojai earthquake of August 20, 2023.

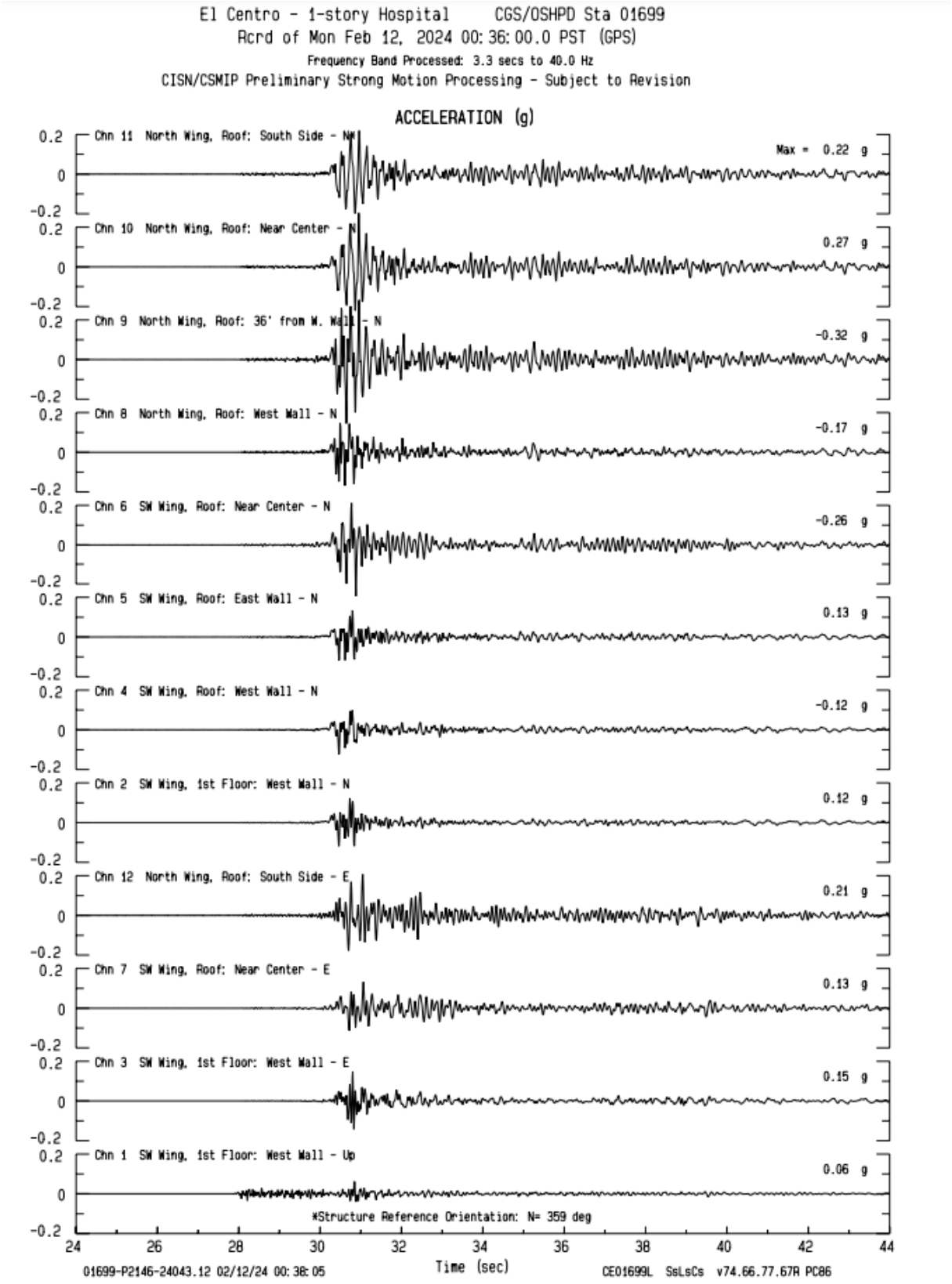


Figure 2. Accelerations recorded at the Regional Hospital in El Centro during the M4.8 El Centro earthquake of February 12, 2024.

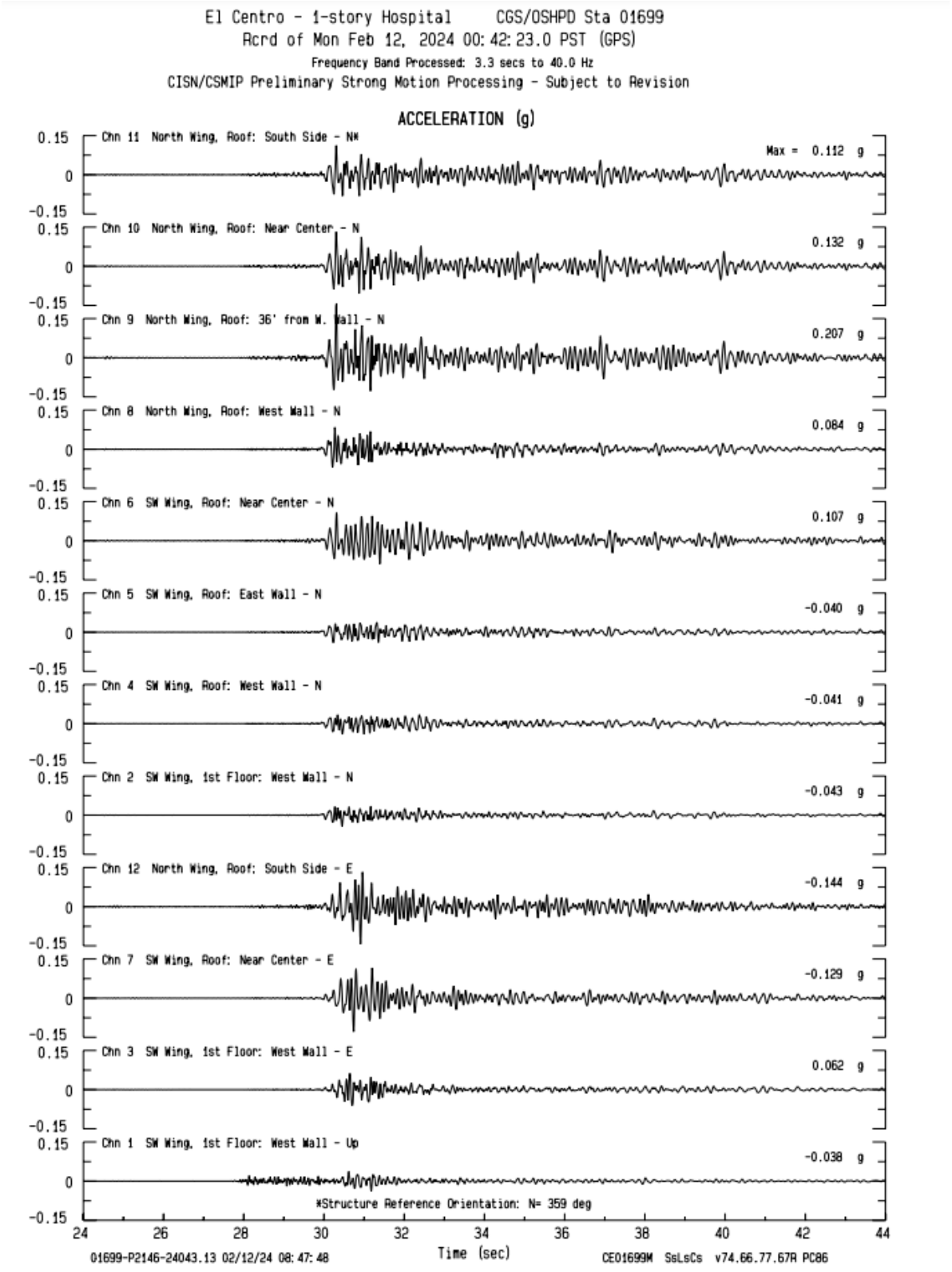
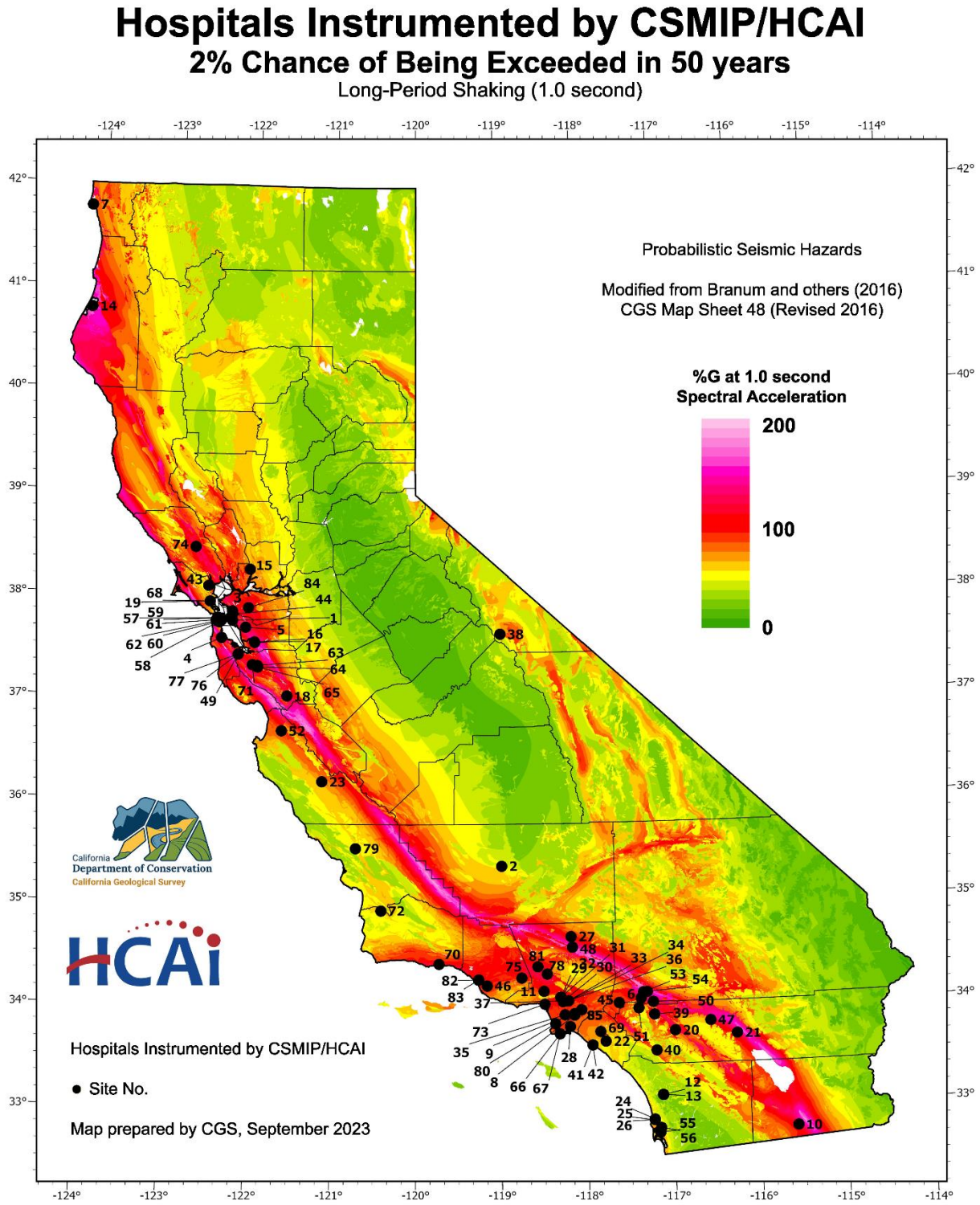


Figure 3. Accelerations recorded at the Regional Hospital in El Centro during the M4.8 El Centro earthquake of February 12, 2024 (second event).

Appendix A

A total of 85 hospital buildings have been instrumented in the HCAI/CSMIP project through the end of FY23-24. The locations of the 85 hospital buildings are shown on a probabilistic seismic hazard map below.



Appendix B

The hospital buildings and information about their structural systems are listed in the table below. The number of strong-motion recorders at each building and the communication speed are also shown in the table as these will determine how quickly data can be recovered for application after earthquakes. Note that the recovery speeds shown in red in the table are for those stations whose speed increased in FY 23-24 from Low (L) to High (H) as a result of the instrumentation upgrade described in Section III of this report.

BUILDINGS INSTRUMENTED BY CSMIP/HCAI 10/1/2024

Site No. on Map	CSMIP Sta. No.	Station Name	No. of Stories	No. of Sensors	No. of Rcrdrs	Recov. Speed	FEMA-310 Bldg Type	SMIAC Bldg Type
1	58396	Alameda - Alameda Hospital	3/0	12+FF	1	M	S1L	K1
2	34234	Bakersfield - Kern County Hospital	4/1	12+FF	1	L	C2M	H2b
3	58496	Berkeley - Alta Bates Hospital	2/1	12	1	L	S2L	I1c
4	58390	Burlingame - Mills Peninsula Hospital (isolated)	6/0	27+FF	1	M	IM	Q2
5	58494	Castro Valley - Sutter Eden Medical Center	6/1	19+FF	1	M	S2M	I2a
6	23788	Colton - San Bernardino Co. Med. Center (isolated)	6/0,4/0,2/0	27+FF	2	H	IM	Q2
7	99261	Crescent City - Sutter Hospital	1/0	10+FF	1	H	S2L	I1c
8	14689	Downey - Kaiser Hospital Tower Expansion	6/partial	16+FF	1	M	S1M	J2b
9	14646	Downey - PIH Health Hospital (VSI)	4/1	12+FF	1	M	C2M	G2b
10	01699	El Centro - Community Hospital	1/0	12+FF	1	H	S2L	I1b
11	24648	Encino - Encino Hospital (VSI)	4/1	12+FF	1	H	RM2M	F2a
12	13476	Escondido - PMC West Hospital Central Plant	2/0	6	1	M	C2L	H1f
13	13473	Escondido - PMC West Hospital (Main Tower)	11/1	12+FF	1	M	S1H	K3a
14	89770	Eureka - St. Joseph Hospital	4/1	11+FF	1	H	C2M	G2d
15	68032	Fairfield - NorthBay Medical Center	3/0	12+FF	1	L	S2L	I1d
16	57301	Fremont - Kaiser Hospital	2/0	15+FF	1	L	S1L	K1
17	57643	Fremont - Washington Hospital (isolated)	3/1	24+FF	1	M	IL	Q1
18	57200	Gilroy - St. Louise Hospital	2/0	10+FF	1	H	S1L	K1
19	58M15	Greenbrae - Marin General Hospital Replacement Building	4/1	16+FF	1	H	S1M	J2b
20	12267	Hemet - Valley Hospital	4/1	10+FF	1	L	C2M	G2d
21	12759	Indio - JFK Hospital	1/0	8+FF	1	H	W1	A1
22	13439	Irvine - Kaiser Sand Canyon Hospital	6/partial	15+FF	1	M	S2M	I2b
23	47231	King City - Mee Hospital	2/0	10+FF	1	L	S2L	I1c
24	03538	La Jolla - Scripps Memorial Hospital	7/1	12+FF	1	M	S1M	J2b
25	03233	La Jolla - UCSD Hospital	2/0	16+FF	1	L	S1L	J1b
26	03593	La Jolla - UCSD Jacobs Medical Center	10/2	24	1	M	S1H	K3a
27	24609	Lancaster - Antelope Valley Hospital	5/0	12+FF	1	H	S1M	K2
28	14735	Long Beach - Miller Children's Hospital	4/0	15+FF	1	H	S1M	J2b
29	24397	Los Angeles - Childrens Hospital	7/1	12	1	H	S1M	K2
30	24713	Los Angeles - Good Samaritan Hospital	8/1	15	1	H	S2H	I3b
31	24662	Los Angeles - Hollywood Presbyterian MC S. Wing (VSI)	4/1	12+FF	1	M	C2M	H2b
32	24682	Los Angeles - Hollywood Presbyterian MC Drs Tower (VSI)	10/2	15	1	M	S1H	J3b
33	24250	Los Angeles - LAC+USC Hospital D&T Bldg (isolated)	6/0	20+FF	1	H	IM	Q2
34	24248	Los Angeles - LAC+USC Hospital IP Bldg	9/0	12	1	H	S2H	I3b
35	14724	Los Angeles - MLK Hospital (isolated)	5/1	21+FF	2	H	IM	Q2
36	24605	Los Angeles - USC Hospital (isolated)	7/1	24	1	H	IH	Q3
37	24260	Los Angeles - USC Hospital Addition	9/1	12	1	L	S2H	I3b
38	54331	Mammoth Lakes - Mammoth Hospital	1/0	10+FF	1	L	S2L	I1b
39	13213	Moreno Valley - Riverside County Hospital	3/1	12+FF	1	L	S1L	K1
40	13601	Murrieta - Rancho Springs Medical Center	2/0	9+FF	1	M	C1L	L1
41	13291	Newport Beach - Hoag Hospital East Tower (isolated)	7/1	27	1	H	IM	Q3
42	13589	Newport Beach - Hoag Hospital West Tower	11/0	18+FF	1	H	C2H	H3a
43	68430	Novato - Community Hospital	2/0	12+FF	1	M	S2L	I1b
44	58590	Oakland - Kaiser Hospital	12/1	18	1	M	S2H	I3b
45	23416	Ontario - Kaiser Hospital	5/partial	18+FF	1	M	S2M	I2b
46	25949	Oxnard - St. Johns Hospital	4/1	16+FF	1	H	S1M	K2
47	12299	Palm Springs - Desert Hospital	4/1	13	1	H	S1M	K2
48	24457	Palmdale - Palmdale Regional Hospital	5/0	16+FF	1	M	C2M	H2d
49	58604	Palo Alto - Lucile Packard Childrens Hospital Stanford	6/2	21	2	M	S2M	J2a
50	23548	Redlands - Community Hospital (VSI)	2/1	9+FF	1	M	C2L	H1c
51	13633	Riverside - Community Hospital (VSI)	6/1	12+FF	1	M	C2M	G2e

Appendix B

BUILDINGS INSTRUMENTED BY CSMIP/HCAI 10/1/2024

Site No. on Map	CSMIP Sta. No.	Station Name	No. of Stories	No. of Sensors	No. of Rcrdrs	Recov. Speed	FEMA-310 Bldg Type	SMIAC Bldg Type
52	47796	Salinas - Natividad Medical Center	3/0	15+FF	1	H	S2L	I1b
53	23634	San Bernardino - Community Hospital	5/0	12+FF	1	M	S1M	K2
54	23697	San Bernardino - St. Bernardine Medical Center	6/0	12+FF	1	H	S1M	J2a
55	03546	San Diego - Sharp Memorial Hospital (VSI)	8/1	15+FF	1	M	C2H	H3b
56	03743	San Diego - UCSD Hospital	11/1	12+FF	1	H	C1H	M3
57	58640	San Francisco - CPMC Cathedral Hill Hospital	12/2	24	1	H	S1H	K3a
58	58574	San Francisco - General Hospital (isolated)	7/2	24+FF	2	M	IM	Q2
59	58718	San Francisco - Kaiser Hospital	6/0	18	1	H	C2M	H2d
60	58649	San Francisco - St. Luke's Hospital	6/1	16	1	M	S2M	I2b
61	58257	San Francisco - UCSF Hospital	15/1	16+FF	1	L	U	U
62	58572	San Francisco - UCSF Mission Bay Hospital	6/0	18+FF	1	M	S2M	I2b
63	57594	San Jose - O'Connor Hospital	5/0	16+FF	1	H	S2M	I2c
64	57495	San Jose - Santa Clara Valley Hospital (Bldg K)	4/1	15	1	M	S1M	K2
65	57537	San Jose - Santa Clara Valley Hospital (Bed Bldg 1)	7/1	20+FF	1	M	S1M	K2
66	14535	San Pedro - Providence LCOM Hosp (Bldg 1T) (VSI)	5/partial	12+FF	1	M	S2M	I2d
67	14536	San Pedro - Providence LCOM Hosp (Bldg 02) (VSI)	4/1	12	1	M	C2M	H2d
68	58755	San Rafael - Marin General Hospital	5/1	12+FF	1	H	S1M	J2b
69	13611	Santa Ana - Orange County Global Medical Center (VSI)	1/0	6+FF	1	M	S2L	I1a
70	25777	Santa Barbara - Cottage Hospital	3/1	9+FF	1	H	C2L	H1e
71	57251	Santa Clara - Kaiser Hospital	3/1	18+FF	1	H	S2L	I1b
72	26470	Santa Maria - Marian Hospital	4/partial	12+FF	1	M	S2M	I2c
73	24202	Santa Monica - St. John's Hospital (isolated)	5/1	24+FF	2	L	IM	Q2
74	68669	Santa Rosa - Kaiser Hospital	4/1	13+FF	1	H	S1M	K2
75	24104	Simi Valley - Simi Valley Hospital	2/1	12+FF	1	H	S1L	K1
76	58623	Stanford - 7-story Hospital (isolated)	7/1	34+FF	1	M	IM	Q2
77	58055	Stanford - University Hospital	3/1	12+FF	1	H	S1L	K1
78	24514	Sylmar - Olive View Medical Center	6/0	13+FF	1	L	UM	R
79	36695	Templeton - Twin Cities Hospital	1/0	9+FF	1	H	W1	A1
80	14529	Torrance - Providence LCOM Hospital (VSI)	4/2	21+FF	2	M	C2M	H2d
81	24344	Valencia - Mayo Hospital	2/partial	12+FF	1	M	S1L	K1
82	25594	Ventura - Community Memorial Hospital	6/1	24+GA	2	M	S2M	I2b
83	25744	Ventura - County Hospital	4/1	12+FF	3	VL	C2M	H2b
84	58199	Walnut Creek - Kaiser Hospital	3/1	16	1	L	S1L	K1
85	14737	Whittier - Presbyterian Intercommunity Hospital	4/1	18+FF	1	H	S1M	J2b