HAZUS 99-SR1: Earthquake Event Report

Region Name: smv682_25

Earthquake Scenario: SMV 68 east thrust 30

Print Date: Wednesday, July 04, 2001

Disclaimer:

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 4 county(ies) from the following state(s):

- California

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 610 square miles and contains 393 census tracts. There are over 573 thousand households in the region and has a total population of 1,633,000 people (1990 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 434 thousand buildings in the region with a total building replacement value (excluding contents) of 89,184 million dollars (1994 dollars). Approximately 96% of the buildings (and 72% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 8,504 and 3,425 million dollars (1994 dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 434,000 buildings in the region which have an aggregate total replacement value of 89,184 million dollars (1994 dollars). Figure 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

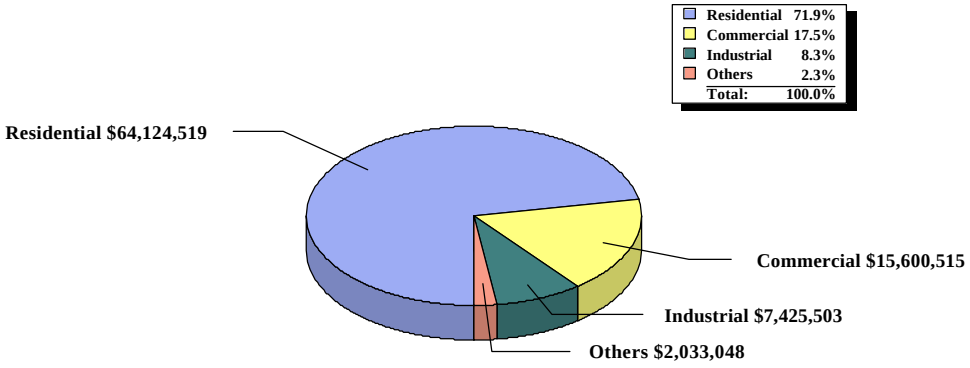

Figure 1: Building Exposure by Occupancy Type
(Thousands of dollars)

In terms of building construction types found in the region, wood frame construction makes up 76% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilites into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 16 hospitals in the region with a total bed capacity of 4,908 beds. There are 689 schools, 26 fire stations, 48 police stations and 8 emergency operation facilities. With respect to HPL facilities, there are 26 dams identified within the region. Of these, 17 of the dams are classified as 'high hazard'. The inventory also includes 5,273 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data is provided in Tables 2 and 3.

The total value of the lifeline inventory is over 9,358 million dollars. This inventory includes over 369 kilometers of highways, 1,295 bridges, 0 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Major Roads	73	3,688
	Bridges	1,291	4,119
	Tunnels	0	0
		Subtotal	7,807
Railways	Rail Tracks	214	372
	Bridges	4	20
	Tunnels	0	0
	Facilities	1	3
		Subtotal	395
Light Rail	Rail Tracks	0	0
	Bridges	0	0
	Tunnels	0	0
	Facilities	0	0
		Subtotal	0
Bus	Facilities	0	0
Ferry	Facilities	0	0
Port	Facilities	0	0
Airport	Facilities	10	50
	Runways	9	252
		Subtotal	302
		Total	**8,504**

Table 3: Utility System Lifeline inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Pipelines	0	0.0
	Facilities	0	0.0
	Distribution Lines	*NA*	1,264.2
		Subtotal	1,264.2
Waste Water	Pipelines	0	0.0
	Facilities	2	120.0
	Distribution Lines	*NA*	758.5
		Subtotal	878.5
Natural Gas	Pipelines	4	10.5
	Facilities	0	0.0
	Distribution Lines	*NA*	505.7
		Subtotal	516.2
Oil Systems	Pipelines	0	0.0
	Facilities	2	4.0
		Subtotal	4.0
Electrical Power	Facilities	0	0.0
	Distribution Lines	*NA*	379.3
		Subtotal	379.3
Communication	Facilities	107	214.0
	Distribution Lines	*NA*	168.6
		Subtotal	382.6
		Total	3,424.8

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	SMV 68 east thrust 30
Type of Earthquake	Arbitrary event
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-121.978
Latitude of Epicenter	37.3006
Earthquake Magnitude	6.8
Depth (Km)	5
Rupture Length (Km)	33.4195
Rupture Orientation (degrees)	125
Attenuation Function	Project 97 West Coast

Building Damage

Building Damage

HAZUS estimates that about 198 thousand buildings will be at least moderately damaged. This is over 46% of the total number of buildings in the region. There are an estimated 20,106 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Residential	88,374	95.75	141,583	98.13	123,717	96.65	46,930	94.68	18,985	94.42
Commercial	2,501	2.71	1,660	1.15	2,594	2.03	1,499	3.02	638	3.17
Industrial	1,102	1.19	872	0.60	1,458	1.14	1,032	2.08	457	2.27
Agriculture	50	1.19	40	0.00	50	0.04	20	0.04	5	0.02
Religion	122	0.13	85	0.00	112	0.09	53	0.11	12	0.06
Government	32	0.03	3	0.00	4	0.00	0	0.00	0	0.00
Education	120	0.13	45	0.03	75	0.06	31	0.06	9	0.04
Total	**92,301**		**144,288**		**128,010**		**49,565**		**20,106**	

Table 5: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	931	1.0	665	0.5	894	0.7	603	1.2	197	1.0
Mobile Homes	1,134	1.2	2,652	1.8	6,971	5.4	7,569	15.3	3,251	16.2
Precast Concrete	991	1.1	512	0.4	1,076	0.8	787	1.6	400	2.0
RM*	7,608	8.2	6,265	4.3	9,909	7.7	7,515	15.2	3,342	16.6
Steel	4,527	4.9	5,019	3.5	11,367	8.9	9,671	19.5	4,288	21.3
URM*	172	0.2	452	0.3	1,047	0.8	1,331	2.7	1,963	9.8
Wood	76,938	83.4	128,723	89.2	96,746	75.6	22,089	44.6	6,665	33.1

*Note:
RM Reinforced Masonry
URM Unreiforced Masonry

Essential Facility Damage

Before the earthquake, the region had 4,908 hospital beds available for use. On the day of the earthquake, the model estimates that only 694 hospital beds (14%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 31% of the beds will be back in service. By 30 days, 60% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		Least Moderate Damage > 50%	Complete Damage > 50%	Functionality > 50% at dav 1
Hospitals	16	14	0	0
Schools	689	497	0	0
EOCs	8	7	0	0
Police Stations	48	27	0	0
Fire Stations	26	26	0	0

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Roads	73			73	73
	Bridges	1,291	502	245	821	1,071
	Tunnels	0	0	0	0	0
Railways	Tracks	0			214	214
	Bridges	4	1	1	4	4
	Tunnels	0	0	0	0	0
	Facilities	1	1	0	1	1
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	10	6	1	6	10
	Runways	9	2	1	9	9

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	2	1	0	0	2
Natural Gas	0	1	0	0	0
Oil Systems	2	1	0	2	2
Electrical Power	0	0	0	0	0
Communication	107	79	8	51	107
Total	**119**	**82**	**8**	**53**	**111**

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	63	14	8
Oil	0	0	0
Total	63	14	8

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	573,147	537,672	516,530	483,853	444,237	0
Electric Power	573,147	239,517	73,967	3,899	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 139 ignitions that will burn about 120 sq. mi (12.4% of the region's total area.) The model also estimates that the fires will displace about 5,100 people and burn about 260 million dollars of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 15.99 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 29% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 640,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 45,218 households to be displaced due to the earthquake. Of these, 26,678 people (out of a total population of 1,633,000) will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening is not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Residential	10,801	1,877	158	158
	Non-Residential	940	173	23	23
	Commute	15	20	34	7
	Total	11,756	2,070	214	187
2 PM	Residential	2,346	407	34	34
	Non-Residential	23,177	4,264	548	548
	Commute	75	100	169	33
	Total	25,598	4,771	752	615
5 PM	Residential	2,786	483	40	40
	Non-Residential	9,362	1,723	223	223
	Commute	222	296	500	97
	Total	12,370	2,503	763	360

Economic Loss

The total economic loss estimated for the earthquake is 21,952 million dollars, which represents 22 % of the total replacement value of the region's buildings. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 21,952 million dollars. 20% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 61% of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss	Structural	1,729.4	749.6	287.0	83.5	**2,849.4**
	Non-Structural	7,455.6	2,055.7	832.9	273.4	**10,617.6**
	Content	2,093.1	1,027.3	639.4	131.9	**3,891.7**
	Inventory	N/A	20.0	89.1	1.5	**110.6**
	Subtotal	11,278.1	3,852.6	1,848.3	490.3	**17,469.3**
Business Interruption Loss	Wage	54.9	642.2	62.3	22.9	**782.3**
	Income	23.3	581.9	37.7	6.8	**649.7**
	Rental	696.4	319.0	47.9	12.8	**1,076.1**
	Relocation	1,267.4	487.0	108.6	111.7	**1,974.6**
	Subtotal	2,042.0	2,030.1	256.5	154.2	**4,482.7**
	Total	13,320.1	5,882.7	2,104.7	644.5	**21,952.0**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

HAZUS estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 15 presents the results of the region for the given earthquake.

Table 13: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Roads	3,687.6	15.9	0.4
	Bridges	4,119.0	764.5	18.6
	Tunnels	0.0	0.0	0.0
	Subtotal	7,806.6	780.4	10.0
Railways	Tracks	372.0	9.4	0.3
	Bridges	20.0	5.9	29.6
	Tunnels	0.0	0.0	0.0
	Facilities	3.0	1.2	40.2
	Subtotal	395.0	16.5	4.2
Light Rail	Tracks	0.0	0.0	0.0
	Bridges	0.0	0.0	0.0
	Tunnels	0.0	0.0	0.0
	Facilities	0.0	0.0	0.0
	Subtotal	0.0	0.0	0.0
Bus	Facilities	0.0	0.0	0.0
Ferry	Facilities	0.0	0.0	0.0
Port	Facilities	0.0	0.0	0.0
Airport	Facilities	50.0	19.8	39.7
	Runways	252.0	8.8	3.5
	Subtotal	302.0	28.6	9.5
		8,503.6	**825.5**	**9.7**

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0	0.0	0.0
	Facilities	0.0	0.0	0.0
	Distribution Lines	1,264.2	*NA*	*NA*
	Subtotal	1,264.2	0.0	0.0
Waste Water	Pipelines	0.0	0.0	0.0
	Facilities	120.0	45.0	37.5
	Distribution Lines	758.5	*NA*	*NA*
	Subtotal	878.5	45.0	5.1
Natural Gas	Pipelines	10.5	0.0	0.1
	Facilities	0.0	0.0	0.0
	Distribution Lines	505.7	*NA*	*NA*
	Subtotal	516.2	0.0	0.0
Oil Systems	Pipelines	0.0	0.0	0.0
	Facilities	4.0	1.4	33.8
	Subtotal	4.0	1.4	33.75
Electrical Power	Facilities	0.0	0.0	0.0
	Distribution Lines	379.3	*NA*	*NA*
	Subtotal	379.3	0.0	0.0
Communication	Facilities	214.0	93.2	43.6
	Distribution Lines	168.6	*NA*	*NA*
	Subtotal	382.6	93.2	43.6
	Total	**3,424.8**	**139.6**	**16.3**

Table 15. Indirect Economic Impact
(with outside aid)

Year(s)	1	2	3	4	5	6-15
Income Impact (millions $	1,003	246	1,107	1,108	1,108	1,108
% Income Impact	2.95	0.72	3.25	3.26	3.26	3.26
Employment Impact (#)	26,867	17,803	43,037	43,065	43,068	43,068
% Employment Impact	2.72	1.80	4.36	4.36	4.36	4.36

Appendix A: County Listing for the Region

California

- Alameda
- San Mateo
- Santa Clara
- Santa Cruz

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
California					
	Alameda	63,200	2,330	1,880	4,220
	San Mateo	153,600	6,330	2,220	8,550
	Santa Clara	1,413,800	55,350	20,940	76,300
	Santa Cruz	2,500	110	10	120
State Total		*1,633,000*	*64,120*	*25,060*	*89,180*
Region Total		**1,633,000**	**64,120**	**25,060**	**89,180**