

If sufficient data on economic impacts to businesses cannot be obtained, the following general strategy for loss estimation using Federal Emergency Management Agency's (FEMA) Earthquake Loss Estimation Methodology may be considered.

Pre-Disaster Economy

To have a basis for comparison, the pre-disaster economy of the affected communities may be characterized. Data can be collected from local and State agencies, regional economic development agencies, the U.S. Census, and State universities. Information should include primary industries, tax base, other revenues, and employment.

Post-Disaster Economy

Estimates of damage to the built environment are typically reported as dollar losses. A methodology was developed to generate an estimate of the consequences to the State, city or region of a disaster. The resulting impact assessment or "loss estimate" generally will describe the scale and extent of damage (intensity) and disruption to the business community and to government revenues as a result of the disaster. The following information is provided by the methodology:

- *Quantitative estimates of losses* in terms of direct costs for repair and replacement of damaged buildings and, where applicable, lifeline system components; indirect costs associated with loss of function (e.g., loss of business revenue); and regional economic impacts.
- *Functionality losses* in terms of loss-of-function and restoration times for buildings, critical facilities such as hospitals, and relevant components of transportation and utility lifeline systems.

Direct Impacts

Direct economic impacts begin with the cost of repair and replacement of damaged or destroyed buildings. However, building damage results in several consequential losses which, in this study are defined as direct. Thus, building-related direct economic losses (which are expressed in dollars) comprise two groups. The first group consists of losses that are directly derived from building damage:

Appendix C

- Cost of repair and replacement of damaged and destroyed buildings
- Costs of damage to building contents
- Losses of building inventory

The second group consists of losses that are related to the length of time the facility is non-operational (or the immediate economic consequences of damage):

- Relocation expense (for businesses and institutions)
- Capital-related income loss (loss of productivity, services or sales)
- Wage loss (consistent with income loss)
- Rental income loss (to building owners)

Damage to utilities and transportation systems can cause direct economic losses analogous to those caused by building damage. In this methodology, direct economic loss for utilities (lifelines) and transportation systems are limited to the cost of repairing damage to the systems, and estimates of elapsed time for their restoration.

Repair or Replacement Costs

Structural repair or replacement costs are defined as the cost per square foot to repair the structure to pre-disaster condition. The regional cost per square foot for construction may be collected from the architectural community and applied to each of the damaged businesses. Consideration should be given for building type and extent of damage (see Table 1).

Non-structural costs such as lighting, ceilings, mechanical and electrical equipment and other fixtures were also assessed as a percent of replacement cost. According to industry experts, non-structural costs average 10 to 12 percent of the replacement cost.

Table 1 Regional Cost Per Square Foot for Construction

Occupancy	Building Type	Cost Per Square Foot to Construct
Commercial	Basic Stick Built	\$50 - 60
Retail	Upscale Stick Built	\$75 - 80
Office	Standard Stick Built	\$60 - 70
Industrial	Steel and Metal	\$25
Industrial	Tiltwall	\$30 - 35

Building Contents

Building Contents are defined as furniture, equipment that is not integral with the structure, computers, and supplies. Contents do not include inventory or non-structural components. Generally, the value of a building's content is expressed as a percentage of the replacement cost of the facility (Table 2). The contents damage percentages are based upon the assumption that for a completely damaged building, some percent of the contents can be retrieved (Table 3).

Table 2 Contents Value as Percentage of Building Replacement Value

Label	Occupancy Class	Contents Value (%)
Commercial		
COM1	Retail Trade	100
COM2	Wholesale Trade	100
COM3	Personal and Repair Services	100
COM4	Professional/Technical/Business Services	100
COM5	Banks	100
COM6	Hospital	150
COM7	Medical Office/Clinic	150
COM8	Entertainment & Recreation	100
COM9	Theaters	100
COM10	Parking	50
Industrial		
IND1	Heavy	150
IND2	Light	150
IND3	Food/Drugs/Chemicals	150
IND4	Metals/Minerals Processing	150
IND5	High Technology	150
IND6	Construction	100
Agriculture		
AGR1	Agriculture	100
Religion/Non/Profit		
REL1	Church/Membership Organization	100
Government		
GOV1	General Services	100
GOV2	Emergency Response	150

Source: FEMA's Earthquake Loss Estimation Methodology, Technical Manual, 1997

Appendix C

Table 3 Percent Contents Damage

Label	Occupancy Class	Non-Structural Damage State			
		Slight	Moderate	Extensive	Complete*
Commercial					
COM1	Retail Trade	1	5	25	50
COM2	Wholesale Trade	1	5	25	50
COM3	Personal and Repair Svcs.	1	5	25	50
COM4	Prof./Tech./ Business Svcs.	1	5	25	50
COM5	Banks/Financial Institutions	1	5	25	50
COM6	Hospital	1	5	25	50
COM7	Medical Office/Clinic	1	5	25	50
COM8	Entertainment & Recreation	1	5	25	50
COM9	Theaters	1	5	25	50
COM10	Parking	1	5	25	50
Industrial					
IND1	Heavy	1	5	25	50
IND2	Light	1	5	25	50
IND3	Food/Drugs/Chemicals	1	5	25	50
IND4	Metals/Minerals Processing	1	5	25	50
IND5	High Technology	1	5	25	50
IND6	Construction	1	5	25	50
Agriculture					
AGR1	Agriculture	1	5	25	50
Religion/Non-Profit					
REL1	Church/Membership Organization	1	5	25	50
Government					
GOV1	General Services	1	5	25	50
GOV2	Emergency Response	1	5	25	50

* At complete damage state, it is assumed that some salvage of contents will take place.

* Source: FEMA's Earthquake Loss Estimation Methodology, Technical Manual, 1997

Business Inventory

Business inventories vary considerably with occupancy. For example, the value of inventory for a high tech manufacturing facility would be very different from that of a retail store. Data can be collected from business owners. The estimation of loss can be based on the value of the inventory at the time of the disaster minus the value of the inventory that was retrievable. When data on retrievable inventory is not available, the percent estimates shown in Table 3 for contents can be used for inventory.

Building Cleanup and Repair Time

The time to repair a damaged building can be divided into two parts: construction and clean-up time, and time to obtain financing, permits and complete a design. Construction time is assumed to be the time needed to do the actual construction or repair. This factor addresses the issue of duration, which is used to determine the short-term and long-term effects.

Repair times differ depending on building occupancy. Simpler and smaller buildings will take less time to repair than more complex, heavily serviced or larger buildings. Establishment of realistic repair times does not translate directly into business or service interruption. For some businesses, building repair time is largely irrelevant, because these businesses can rent alternative space or use spare industrial/commercial capacity elsewhere. Thus, building and service interruption time multipliers that were developed for FEMA's Earthquake Loss Estimation Methodology (Table 4) can be used to arrive at estimates of business interruption for economic purposes. These values are multiplied by the combined building cleanup and repair times (Tables 5 and 6).

Appendix C

Table 4 Building and Service Interruption Time Multipliers

Label	Occupancy Class	Construction Time				
		Structural Damage State				
		None	Slight	Moderate	Extensive	Complete
Commercial						
COM1	Retail Trade	0.5	0.1	0.1	0.3	0.4
COM2	Wholesale Trade	0.5	0.1	0.2	0.3	0.4
COM3	Personal & Repair Services	0.5	0.1	0.2	0.3	0.4
COM4	Prof./Tech.Business Svcs.	0.5	0.1	0.1	0.2	0.3
COM5	Banks/Financial Institutions	0.5	0.1	0.05	0.03	0.03
COM6	Hospital	0.5	0.1	0.5	0.5	0.5
COM7	Medical Office/Clinic	0.5	0.1	0.5	0.5	0.5
COM8	Entertainment & Recreation	0.5	0.1	1	1	1
COM9	Theaters	0.5	0.1	1	1	1
COM10	Parking	0.1	0.1	1	1	1
Industrial						
IND1	Heavy	0.5	0.5	1	1	1
IND2	Light	0.5	0.1	0.2	0.3	0.4
IND3	Food/Drugs/Chemicals	0.5	0.2	0.2	0.3	0.4
IND4	Metals/Minerals Processing	0.5	0.2	0.2	0.3	0.4
IND5	High Technology	0.5	0.2	0.2	0.3	0.4
IND6	Construction	0.5	0.1	0.2	0.3	0.4
Agriculture						
AGR1	Agriculture	0	0	0.05	0.1	0.2
Religion/Non-Profit						
REL1	Church/Membership Org.	1	0.2	0.05	0.03	0.03
Government						
GOV1	General Services	0.5	0.1	0.02	0.03	0.03
GOV2	Emergency Response	0.5	0.1	0.02	0.03	0.03

* Source: FEMA's Earthquake Loss Estimation Methodology, Technical Manual, 1997

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Table 5 Building Cleanup and Repair Time (Construction) (Time in Days)

Label	Occupancy Class	Construction Time				
		Structural Damage State				
		None	Slight	Moderate	Extensive	Complete
Commercial						
COM1	Retail Trade	0	5	30	90	180
COM2	Wholesale Trade	0	5	30	90	180
COM3	Personal & Repair Services	0	5	30	90	180
COM4	Prof./Tech./Business Svcs.	0	5	30	120	240
COM5	Banks/Financial Institutions	0	5	30	90	180
COM6	Hospital	0	10	45	180	360
COM7	Medical Office/Clinic	0	10	45	180	240
COM8	Entertainment & Recreation	0	5	30	90	180
COM9	Theaters	0	5	30	120	240
COM10	Parking	0	2	20	80	160
Industrial						
IND1	Heavy	0	10	30	120	240
IND2	Light	0	10	30	120	240
IND3	Food/Drugs/Chemicals	0	10	30	120	240
IND4	Metals/Minerals Processing	0	10	30	120	240
IND5	High Technology	0	20	45	180	360
IND6	Construction	0	5	20	80	160
Agriculture						
AGR1	Agriculture	0	2	10	30	60
Religion/Non-Profit						
REL1	Church/Membership Org.	0	10	30	120	240
Government						
GOV1	General Services	0	10	30	120	240
GOV2	Emergency Response	0	5	20	90	180

* Source: FEMA's Earthquake Loss Estimation Methodology, Technical Manual, 1997

Appendix C

Table 6 Building Recovery Time (Time in Days)

Label	Occupancy Class	Construction Time				
		Structural Damage State				
		None	Slight	Moderate	Extensive	Complete
Commercial						
COM1	Retail Trade	0	10	90	270	360
COM2	Wholesale Trade	0	10	90	270	360
COM3	Personal & Repair Services	0	10	90	270	360
COM4	Prof./Tech./Business Svcs.	0	20	90	360	480
COM5	Banks/Financial Institutions	0	20	90	180	360
COM6	Hospital	0	20	135	540	720
COM7	Medical Office/Clinic	0	20	135	270	540
COM8	Entertainment & Recreation	0	20	90	180	360
COM9	Theaters	0	20	90	180	360
COM10	Parking	0	5	60	180	360
Industrial						
IND1	Heavy	0	10	90	240	360
IND2	Light	0	10	90	240	360
IND3	Food/Drugs/Chemicals	0	10	90	240	360
IND4	Metals/Minerals Processing	0	10	90	240	360
IND5	High Technology	0	20	135	360	540
IND6	Construction	0	10	60	160	320
Agriculture						
AGR1	Agriculture	0	2	20	60	120
Religion/Non-Profit						
REL1	Church/Membership Org.	0	5	120	480	960
Government						
GOV1	General Services	0	10	90	360	480
GOV2	Emergency Response	0	10	60	270	360

* Source: FEMA's Earthquake Loss Estimation Methodology, Technical Manual, 1997

Relocation Expenses

Relocation costs may be incurred when the level of building damage is such that the building or portions of the building are unusable while repairs are being made. While relocation costs may include a number of expenses, the following components are typically considered: disruption costs that include the cost of shifting and transferring, and the rental of temporary space. Both of these are measured in dollars per square foot per day (see Table 7). It should be noted that relocation expenses are assumed to be incurred only by building owners. A renter who has been displaced from a property due to disaster damage will

Application of Hazus Earthquake Loss Estimate Methodology

Table 7 Rental Costs and Disruption Costs

Label	Occupancy Class	Construction Time		Disruption Costs
		(\$/ft ² /month)	(\$/ft ² /day)	(\$/ft ²)
Commercial				
COM1	Retail Trade	0.85	0.03	0.80
COM2	Wholesale Trade	0.35	0.01	0.70
COM3	Personal and Repair Services	1.00	0.03	0.70
COM4	Professional/Technical/Business Services	1.00	0.03	0.70
COM5	Banks	1.25	0.04	0.70
COM6	Hospital	1.00	0.03	1.00
COM7	Medical Office/Clinic	1.00	0.03	1.00
COM8	Entertainment & Recreation	1.25	0.04	N/A
COM9	Theaters	1.25	0.04	N/A
COM10	Parking	0.25	0.01	N/A
Industrial				
IND1	Heavy	0.15	0.01	N/A
IND2	Light	0.20	0.01	0.70
IND3	Food/Drugs/Chemicals	0.20	0.01	0.70
IND4	Metals/Minerals Processing	0.15	0.01	0.70
IND5	High Technology	0.25	0.01	0.70
IND6	Construction	0.10	0.00	0.70
Agriculture				
AGR1	Agriculture	0.50	0.02	0.50
Religion/Non/Profit				
REL1	Church/Membership Organization	0.75	0.03	0.70
Government				
GOV1	General Services	1.00	0.03	0.70

* Source: FEMA's Earthquake Loss Estimation Methodology, Technical Manual, 1997

cease to pay rent to the owner of the damaged property and only pay rent to the new landlord. Therefore, the renter has no new rental expenses. It is assumed that the owner of the damaged property will pay the disruption costs for his renter. If the damaged property is owner-occupied, then the owner will have to pay for his own disruption costs (Table 7) in addition to the cost of rent while he is repairing his building. Relocation expenses are then a function of the floor area, the rental costs per day per square foot, a disruption cost, and the expected days of loss of function.

Capital-Related Income

Capital-related income is a measure of the profitability of a commercial enterprise. Income losses occur when building damage disrupts commercial activity. Income losses are the product of floor area, income realized per square foot and the expected days of loss of function. The U.S. Department of Commerce's Bureau of Economic Analysis Regional reports estimates of capital-related income by economic sector. Capital-related income per square foot of floor space can then be derived by dividing income by the floor space occupied by a specific sector. When owner supplied data is unavailable, the factors in Table 8 can be used.

Indirect Impacts

Indirect economic impacts are defined as the long-term economic impacts on the region that occur as a result of direct economic losses. Examples might be a change in unemployment or sales tax revenues. Disasters may produce impacts on economic sectors not sustaining direct damage. Activities that rely on regional markets for their output or that rely on a regional source of supply could experience interruptions in their operations. Such interruptions are called indirect economic losses. The extent of these losses depends upon such factors as the availability of alternative sources of supply and markets for products, the length of the production disturbance, and deferability of production.

Quantifying a regional economy is very complex, especially if it includes such factors as the ability to replace lost inventory or lost production by products from other regions. Therefore, indirect impacts may be evaluated using such factors as changes in employment, sales tax loss, and multiplier effect.

Application of Hazus Earthquake Loss Estimate Methodology

Table 8 Proprietor's Income

Label	Occupancy Class	Income		Wages	Employees	Output
		Per Sq. Ft. Per Year	Per Sq. Ft. Per Day	Per Sq. Ft. Per Day	Per Sq. Ft.	Per Sq. Ft. Per Day
Commercial						
COM1	Retail Trade	16.299	0.045	0.156	0.004	0.330
COM2	Wholesale Trade	26.731	0.073	0.192	0.002	0.429
COM3	Personal & Repair Services	35.220	0.096	0.227	0.004	0.506
COM4	Prof./Tech./Business Svcs.	277.520	0.760	0.270	0.004	0.739
COM5	Banks	316.683	0.868	0.440	0.006	2.399
COM6	Hospital	44.025	0.121	0.284	0.005	0.632
COM7	Medical Office/Clinic	88.050	0.241	0.568	0.010	1.264
COM8	Entertainment & Recreation	161.474	0.442	0.352	0.007	0.797
COM9	Theaters	52.830	0.145	0.341	0.006	0.759
COM10	Parking	0.000	0.000	0.000	0.000	0.000
Industrial						
IND1	Heavy	66.808	0.183	0.303	0.003	1.281
IND2	Light	66.808	0.183	0.303	0.003	1.281
IND3	Food/Drugs/Chemicals	89.077	0.244	0.405	0.004	1.708
IND4	Metals/Minerals Processing	202.395	0.555	0.313	0.003	1.355
IND5	High Technology	133.616	0.366	0.607	0.006	2.561
IND6	Construction	65.133	0.178	0.328	0.005	1.269
Agriculture						
AGR1	Agriculture	61.810	0.169	0.067	0.004	0.632
Religion/Non/Profit						
REL1	Church/Membership Org.	35.220	0.096	0.227	0.004	1.264
Government						
GOV1	General Services	28.925	0.079	2.180	0.025	0.506
GOV2	Emergency Response	0.000	0.000	3.314	0.038	0.581

*Source: FEMA's Earthquake Loss Estimation Methodology, Technical Manual, 1997

