World Trade Center Disaster

RMS Special Report
September 18, 2001

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SUMMARY

This report summarizes research, and limited on-site reconnaissance, conducted over the past week to help qualify, and quantify as best as possible, the magnitude of the damage and insured loss from the September 11 disaster at the World Trade Center. In preparing this information, RMS is mindful that this catastrophe has directly impacted many of our clients, their offices, and most critically their personnel.

This unprecedented catastrophe presents a difficult challenge to all who are trying to estimate potential exposures and losses. The lack of authoritative information is evoking considerable speculation. Last Friday, Sax Riley, Lloyd's chairman said that loss quantification at this stage was meaningless, and the week's events had "generated the most complex set of insurance liabilities and inter-dependencies the industry has ever seen."[i] On Monday, an opinion was finally given on a key question affecting all loss estimation efforts. According to Hannover Re, the "$4.1 billion property insurance policy covering the World Trade Center did not include an explicit terrorism exclusion clause within the contract."[ii] Therefore, it is now quite likely that the insurance industry will cover the majority of claims arising from this disaster.

Although RMS does not explicitly model this type of event, modeling analytics and lessons from natural catastrophes can provide some useful guidance in helping frame the potential insurance consequences of this tragedy. Insured losses from this disaster will come from several main categories: Property Damage, Business Interruption, Casualty, Liability, and Aviation covers.

In this report, RMS concentrates on identifying the property impacts and potential losses. RMS estimates that the property component of losses will be $7 to $11 billion, including building, contents, and direct business interruption losses generally associated with property claims. This estimate is based on an analysis of the damage mechanisms, exposure densities, and replacement costs for five damage potential zones in the disaster region. More details are provided in the Property Damage section of this report. An additional section discusses issues affecting contingent business interruption, casualty, aviation, and liability losses for this disaster.

As major re/insurers release early estimates, rating agencies and analysts are estimating that the total industry loss will be in the $20 to $30 billion range.[iii] Based upon the analysis outlined herein, RMS expects that the total insured loss may reach, or even exceed, $25 billion, making this the costliest insured catastrophe in history. Furthermore, the nature of the likely losses, and loss concentrations within the commercial sector, suggest that a significant portion of the total loss will be borne ultimately by the reinsurance industry, particularly institutions outside the U.S. While the overall loss will be unprecedented, it is important to note that most re/insurers' balance sheets, and the industry as a whole, are capitalized to withstand catastrophe losses well in excess of the current estimates for this event. For example, the 100-year natural catastrophe loss in the U.S. is about $50 billion in property losses alone.

Key factors influencing the total loss outcome are the business community's ability to recover quickly, as well as liability issues. RMS will continue to research this disaster and refine our analyses as engineering surveys are completed and more information becomes available.

PROPERTY DAMAGE

Property-related claims for the WTC disaster will include building, contents, and direct business interruption losses. Contingent, or indirect, business interruption losses are discussed in a following section.

Property losses will extend well beyond the immediate devastation zone surrounding the World Trade Center (WTC) towers. Although this disaster is of a very different magnitude, its impact is not unlike the 1995 Oklahoma City bombing of the 9-story Alfred P. Murrah building, which severely damaged or destroyed 25 nearby buildings and damaged another 300.[iv]

To estimate the nature and intensity of the loss extent beyond the WTC towers, RMS has researched a series of potential damage mechanisms and considered the loss levels each is likely to have caused. A set of concentric zones has been defined, centered on the WTC complex, in order to categorize the levels of property damage and potential levels of loss (see Figure 1).

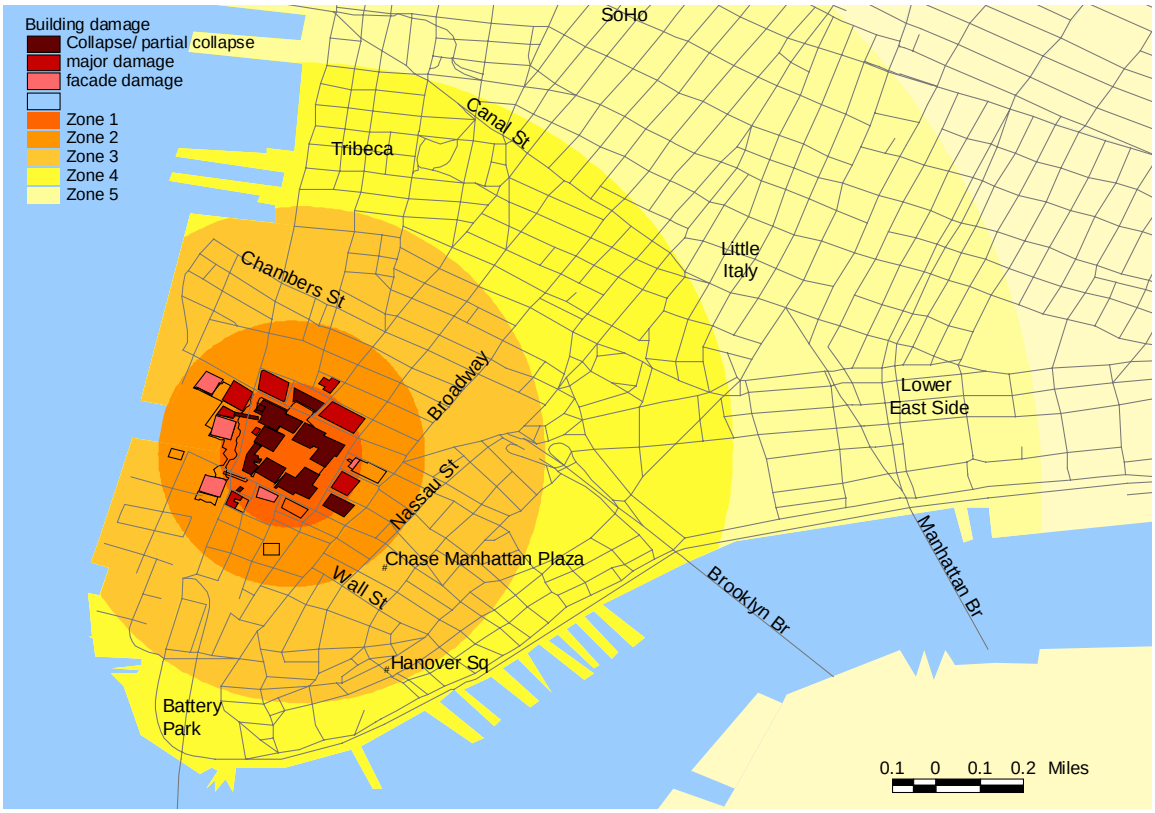

Figure 1. Buildings in the WTC complex and Five Damage Potential Zones

Building heights, commercial and residential square footages, replacement costs, and industry exposure values were then used to estimate potential loss ranges within each zone (see Figure 2). Sources of information for these calculations include: RMS 2000 Industry Exposure Database; Dun and Bradstreet commercial square footage; Marshall & Swift building replacement cost data; and New York City Area Consortium for Earthquake Loss Mitigation, Year Two Technical Report, 1999-2000.

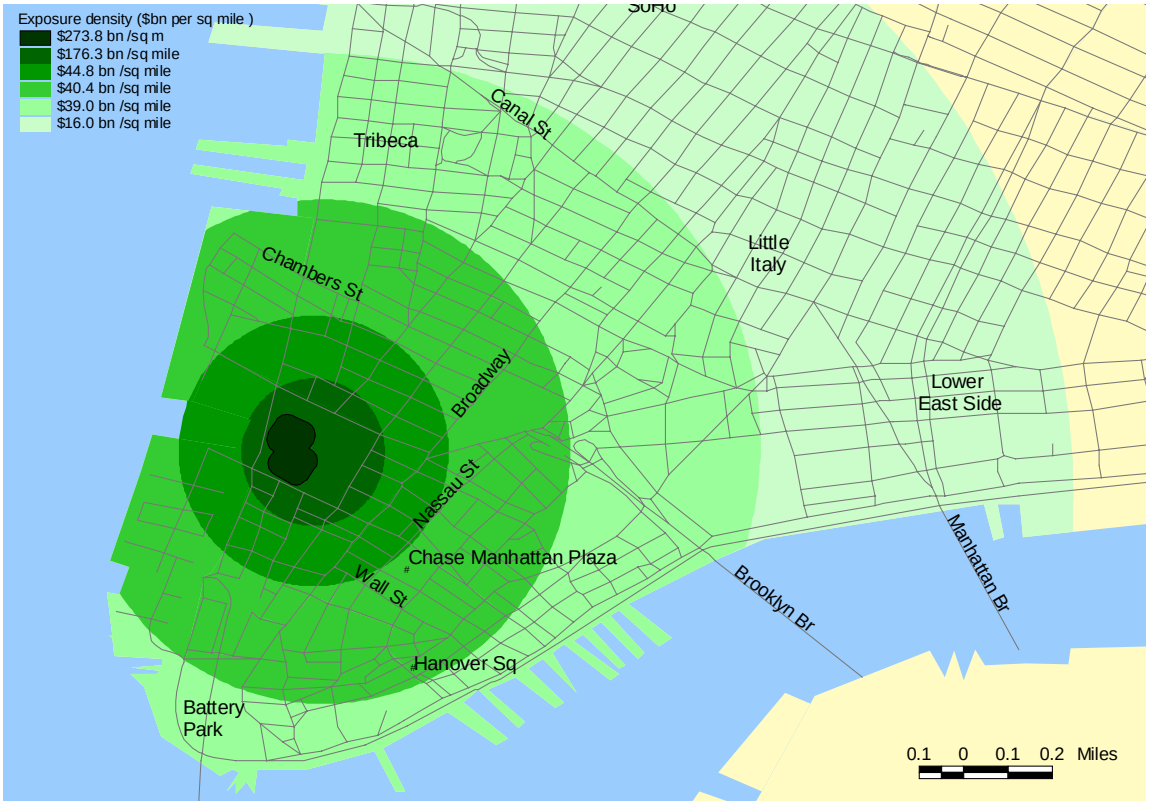

Figure 2. Exposure Density ($Billion per sq. mi) in Five Damage Potential Zones

Estimates resulting from this analysis are still approximate. As reports become clearer, damage levels for each affected building will be established, and loss estimates can then be refined. There are several (public access) web sites that clients can consult for details on specific buildings within the disaster zone. Two recommended web sites are: www.mrofficespace.com, and www.skyscrapers.com.

Damage Mechanisms

Beyond the collapse of the two main towers, losses in this disaster were caused by five key damage mechanisms.

Fire

Buildings in close proximity to the WTC were vulnerable to fire from the conflagration of the collapsed, burning towers. Given that the fire department was focused on life safety issues on-site, fire fighting in evacuated facilities was minimal. The extent of fire damage to these buildings could be extensive and may have played a role in the collapse or severe structural damage of several of these structures.

Massive Projectile Debris
Massive debris-related damage was caused by falling debris generated as the towers collapsed. This debris includes the bulk of building mass that disintegrated over a footprint 2 to 3 times the radius of each building's base, as well as large steel and concrete beams that, during the implosion of the towers, were ejected well beyond this footprint area. This is likely to be the principal agent of damage for most buildings near the WTC complex.

Airborne Debris
The pancake collapse of the tower floors created a major airborne "debris-surge" laden with all kinds of materials ejected in the collapse. The debris-surge cloud initially spread out at very high speeds of over 50 mph (80 km/hr). It then channeled into the surrounding canyon streets, spreading more than 1/2 mile (800 m) from the WTC site. As in a volcanic eruption, the maximum particle size decreased with distance away from the site. Close in, the airborne debris is up to 2 inches (50 mm). A thin film of dust resulting from the collapse and the ash from the fires was reported as far away as Greenwich Village – 2 miles (3,200 m) from the WTC complex.

Pressure Wave
The rapid collapse of the towers created a pressure wave, similar to very strong wind gusts, that affected buildings near the WTC complex. This wave caused some damage to windows and cladding on buildings within, at most, 650 feet (200 m) of the WTC complex (which is generally within the zone also affected by massive debris damage).

Vibration and Ground Deformation
The WTC complex and surrounding area is built on thick fill over bedrock. Any ground deformation associated with a sudden transfer of load would potentially damage the foundations of non-piled buildings, roads, and underground infrastructure, including pipes and the subway. Reports of gas leaks and road damage are now emerging, probably caused by the collapse of underground structures triggered by the impact of the collapsing towers. There is speculation that the collapses caused ground vibrations sufficient to have damaged some nearby properties. Since there are no confirmed reports of vibrational damage, this analysis assumes that vibrations alone did not cause losses.

Damage Potential Zones and Loss Levels

Considering various reports and potential damage mechanisms, five damage potential zones and their distance from the WTC complex have been estimated. A detailed discussion of the damage mechanisms, potential loss levels, and exposed values in each zone follows.

Zones	*Radius from WTC*	*Exposed Property ($ millions)*	*Avg. Loss Levels*	*Property Loss Potential*
1. Collapse & Fire	650 ft (200 m)	$9,849	50% to 100%	$7 - $9.6 billion
2. Massive Debris	1,300 ft (400 m)	$2,165	10% to 20%	<$500 million
3. Thick Airborne Debris	0.5 mi (800 m)	$21,810	1% to 2%	<$450 million
4. Thin Airborne Debris	1 mi (1,600 m)	$30,131	<0.5%	<$150 million
5. Far-Field Impacts	2 mi (3,200 m)	$21,675	<0.1%	<$20 million
Totals		$85,630		$7 - $11 billion

Zone 1 - Collapse and Fire
Radius: 650 feet (200 meters)
Zip Code: 10048
Buildings and Boundaries: Includes the World Trade Center, towers 2, 3 and 4 of the World Financial Center, One Liberty Plaza, the Millenium Hotel, 90 West Street
Estimated Building Square Footage: 29.4 million (100% commercial)
Avg. Replacement Cost[v] (per sq. ft): ~$335
Damage Description: Damage caused primarily by building collapse, fire, and massive debris surcharge onto neighboring buildings. Damage may have resulted also from the pressure wave and ground vibration. Fire ignitions are reported in at least 2 neighboring buildings. Each tower has a footprint area of 40,000 square feet (60m x 60m). Both collapses were mainly vertical with relatively minor angles of fall. The south tower collapsed in a southeast direction and the north tower in a northwest direction. Exterior structural damage is evident on buildings near the collapse zone. The majority of building mass from each tower appears to cover an area extending 650 feet (200 meters) from the center of each tower. The radius for large-sized debris extends beyond this footprint, up to 1,300 feet (400 meters) away. Thick dust up to 2 inches (50 mm) within this zone could cause major damage. For example, ash from volcanic eruptions has been known to cause significant property loss by clogging air conditioning and other mechanical and engineering (M&E) plants in highly serviced buildings. Although the total volume of dust produced by the WTC collapses is not necessarily comparable, varying levels of damage across a wide area may result from dust clogging and penetration.
Loss Assumptions: WTC Complex – 100%; Surrounding buildings – 50% to 90%

Zone 2 – Massive Debris
Radius: 1,300 feet (400 meters)
ZIP Codes: 10281, and parts of 10006, 10007, 10005 and 10038
Buildings and Boundaries: Encompasses the area west of Nassau St, north of Rector St, and south of Warren St., and incorporates the rest of the World Financial Center
Estimated Building Square Footage: 6.5 million (80% commercial; 20% residential)
Avg. Replacement Cost (per sq. ft): ~$330
Damage Description: This zone is beyond the range of fire spread and damage mechanisms are primarily from falling debris, collapse, possible pressure waves resulting from the collapse, and airborne debris. Building damage is characterized by large debris falling on roofs, damaged cladding, and many broken windows. Structural damage is suspected on many buildings in this zone, and engineering surveys are being conducted. The few collapses within this zone may have been caused by the additional loads generated from debris landing on their roofs. Remaining buildings may have suffered serious roof damage as well as structural distress short of collapse. Photographs of the collapses show parabolic plumes of large pieces of debris thrown out by the collapse. There are isolated reports of missiles and debris pieces landing up to 1,600 feet (500m) away. Debris-related projectiles may cause significant damage to cladding and roofs. Dense dust over 1 inch (25 mm) within this zone could cause major damage. There are media reports of buildings whose air conditioning systems cannot restart, due to dust-related damages. Dust penetrates into building interiors, either through broken windows or through air conditioning systems. It can damage sensitive IT equipment, finishes and furnishings of the buildings, which can lead to expensive re-equipping and refurbishing costs.
Loss Assumptions: 10% to 20% loss levels

Zone 3 – Thick Airborne Debris
Radius: 0.5 mile (800 meters)
ZIP Codes: 10280, 10004, 10005, the west part of 10038 and point codes 10279 and 10278
Buildings and Boundaries: Encompasses most of the streets south of Chambers Street, north of Battery Park and west of Water Street; this includes the 9 to 10 block area around the WTC complex, which police cordoned off during the first week, as well as Wall Street
Estimated Building Square Footage: 72.7 million (65% commercial; 35% residential)
Avg. Replacement Cost (per sq. ft): ~$300
Damage Description: Scattered items of smaller debris and wind-blown missiles could cause damage by falling on roofs and breaking windows. Deep dust of 0.5 inches (10mm) is possible within this zone, resulting in mechanical damage (e.g. clogging to air conditioners) and damage to equipment and finishes. Electrical power outages, lasting at least 5 days, extend into this zone. Media reports also suggest that building damage extends into this zone, although the frequency and severity of the damage will only emerge with full professional surveys.
Loss Assumptions: 1% to 2% loss levels

Zone 4 – Thin Airborne Debris
Radius: 1 mile (1,600 meters)
ZIP Codes: 10013, northern part of 10007 and 10038
Buildings and Boundaries: This area encompasses streets south of Canal St and Catherine St., including the County and U.S. courthouse areas
Estimated Building Square Footage: 103.9 million (65% commercial; 35% residential)
Avg. Replacement Cost (per sq. ft): ~$290
Damage Description: Thick dust of 0.25 inches (5mm) is possible within this zone, requiring major clean-up and resulting in mechanical damages as well as damage to equipment and finishes.
Loss Assumptions: <0.5%

Zone 5 – Far-Field Impacts
Radius: 2 miles (3,000 meters)
ZIP Codes: 10012, 10014 and 10002
Buildings and Boundaries: The northern boundary of this area is Washington Square
Estimated Building Square Footage: 85.6 million (65% commercial; 35% residential)
Avg. Replacement Cost (per sq. ft): ~$250
Damage Description: Light dust of 0.04 inches (1mm) is possible within this zone, requiring clean-up and possibly resulting in damages to equipment and finishes.
Loss Assumptions: <0.1%

OTHER KEY LOSS COMPONENTS

Contingent Business Interruption

The economic consequences of business interruption in this disaster will be significant, and there are a host of issues to be considered. It is likely that many building owners and tenants in Lower Manhattan had business interruption cover because of the critical nature of their financial operations, as well as the experiences gained from the 1993 WTC bombing. This section considers the causes and potential scope of contingent, or indirect, business interruption, which typically is not an insured loss.

Quantifying the recovery time for such an unprecedented disaster is difficult. Key factors to consider are: 1) the likely duration of infrastructure and service disruptions, and 2) the ability of companies to implement contingency plans and establish alternative facilities quickly. Jones Lang LaSalle, property consultants, estimates that 20 million square feet of office space in Lower Manhattan will be severely affected for some time.[vi]

One week after the disaster, a large portion of Lower Manhattan was still without power. Electrical power outages across the financial district were reportedly caused by the WTC collapse onto two adjacent substations. A ConEd spokesman said that "the damage is pretty substantial, and we haven't even begun to assess when it will be repaired."[vii] Telephone service has also been impacted.

Speculation is likely to continue for some time about whether this level of business interruption will result in significant long-term economic impacts on Manhattan's financial sector, as well as the U.S. and international economy. Earthquakes in other industrialized areas, such as California, Japan, and Taiwan, have led to significant business interruption losses and subsequent economic impacts from infrastructure disruption (associated with long repair times).

In the 1994 Northridge Earthquake, public infrastructure repairs (primarily to damaged highways and underground utilities) cost more than $6 billion of the estimated $40 billion economic price tag. Total commercial losses are estimated at $15 billion, of which the insured loss is estimated at $4 billion and the business interruption costs (largely uninsured) are believed to be more than $6 billion.[viii] Similarly, the transportation and economic disruptions associated with the 1995 Kobe, Japan Earthquake were also high, and the long-term impacts on two of Kobe's main business sectors - cargo shipping and synthetic shoe production - were significant. In Taiwan, the insurance industry's $1 billion loss for the 1999 earthquake came mostly for business interruption and damage to the "chip" manufacturing industry, severely impacted by the island-wide power disruption.[ix]

While it is still early, there are some small bits of evidence that the impacts, particularly on Manhattan, are not going to be as severe as initially feared. Several major financial institutions affected by this disaster, including Lehman Brothers, Morgan Stanley, Salomon Smith Barney, and Merrill Lynch, have implemented contingency plans and are transitioning operations to alternative sites. Many cite success from the Y2K contingency planning undertaken in the recent past.

On Sunday night, September 16, Richard Grasso, Chairman of the New York Stock Exchange stated: "We have rebuilt the infrastructure to the point where I'm confident that 85 million Americans can be back in the greatest market in the world."[x] Power and telephone services were restored to many businesses in Lower Manhattan in anticipation of Monday's market opening.

Casualty

As of Tuesday, September 18, New York City reports 218 confirmed deaths and 5,422 missing people. The numbers of individuals who were able to evacuate before the collapse are far higher than initially believed. Four major components of casualty losses to consider in estimates are: life insurance, accidental death and dismemberment (AD&D) coverage, long-term disability insurance, and worker's compensation.

Life insurance and AD&D coverage for employees are not mandatory benefits; however, employee benefit packages are likely to include all these components. Quantifying an average claim value is difficult since employee benefits vary greatly across companies and for different employees, especially executives. Principal Financial Groups estimates that employer-offered life insurance coverage is often equal to ½ annual earnings.[xi] Other industry sources estimate standard covers equaling 2 to 2 ½ times annual earnings with maximum limits of $500,000. The same estimates of 2 to 2 ½ times annual earnings with maximum limits of $500,000 have also been given for standard AD&D covers. In addition to employee benefits, there will be additional life insurance policies carried by individuals and spouses.

In the Loma Prieta and Northridge earthquakes, insurance payouts for fatalities averaged about $1 million per person.[xii] Several industry contacts suggest that this figure is a reasonable starting point for estimating these losses. For the banking and insurance industries, estimates of as much as 5 to 10 times annual salary for life insurance pay-offs have also been given.

New York state law has one of the lowest levels of statutory worker's compensation in the U.S. - with a maximum lifetime benefit of $400 per week ($21,000 annually) to the surviving spouse/dependents along with lifetime health care benefits - irrespective of how highly the worker was originally compensated.[xiii] Maximum limits are not known. Long-term disability benefits may be equal to 50% to 70% of annual earnings with maximum limits.

Aviation and Liability

Liability issues are likely to be significant for this disaster. Aviation policies cover not only the loss of the aircraft but also the bodily injury and property damage caused by the four crashes. Aviation losses will result from both the hull covers and aviation liabilities. There are estimates that the hull cover for the four downed aircraft total $500 million. In addition, there remains some uncertainty as to the extent of third party aviation liabilities. However, according to Hannover Re, "the limits of coverage of these policies for third party liability are $1.5 billion per event."[xiv]

Other third-party liability claims will result from a wide range of circumstances. It is difficult to estimate the total likely amount for these claims. However, it may be instructive to consider the liability claims modeled by RMS for catastrophic earthquakes. For example, RMS estimates general liability losses of $6 to $7 billion from a major earthquake impacting the Los Angeles region.[xv] Liability losses in this disaster may be comparable.

ENDNOTES

[i] Insurance Day, September 14, 2001

[ii] Reactions, September 17, 2001

[iii] Reuters, September 17, 2001

[iv] Final Report: Alfred P. Murrah Federal Building Bombing, April 19, 1995, Fire Protection Publications, Oklahoma State University, 1996

[v] Average replacement cost estimates are based on Marshall & Swift data, adjusted to account for contents replacement and direct business interruption costs.

[vi] Financial Times, September 14, 2001

[vii] New York Times, September 16, 2001

[viii] Petak, William, et al. 2000. The Northridge, Earthquake and Its Economic and Social Impacts. Conference on Earthquake Risks in Europe, IIASA, Laxenburg, Austria, July 6-9, 2000

[ix] Event Report: Chi-Chi, Taiwan Earthquake. RMS, 2000

[x] CNN, September 17, 2001

[xi] New York Times, September 13, 2001

[xii] What If A Major Earthquake Strikes the Los Angeles Area? RMS, September, 1995

[xiii] New York Times, September 13, 2001

[xiv] Insurance Day, September 17, 2001

[xv] What If A Major Earthquake Strikes the Los Angeles Area? RMS, September, 1995

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