M/V Cosco Busan

HIGHWAY FACTORS FACTUAL REPORT

13 Pages)

NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C. 20594

ACCIDENT

Vessel:	***M/V Cosco Busan***
Date:	November 7, 2007
Time:	0830 hrs Pacific
Location:	San Francisco Harbor, Oakland Bay Bridge, Span D-E, 37° 48.1 N, 122° 22.5 W
Owner/Operator:	Regal Stone Ltd./ Fleet Management
Complement:	24 Crew, 1 Pilot

1 HIGHWAY FACTORS FACTUAL REPORT

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Note: Caltrans and FHWA were not Parties to the investigation, but provided valuable information to assist the investigation.

2 ACCIDENT SUMMARY:

On Wednesday, November 7, 2007, about 0830 Pacific standard time, the Hong Kong-registered, 901-foot container ship *Cosco Busan* allided with the fendering system at the base of the Delta tower of the San Francisco-Oakland Bay Bridge (Bay Bridge). The ship was outbound from berth 56 in the Port of Oakland carrying 2,529 containers. It was destined for Busan, Korea.

The vessel was scheduled to depart the berth at 0630. A San Francisco Bar pilot arrived at the vessel about 0620 and met with vessel's master. Fog had restricted visibility in the harbor, and the pilot and master postponed sailing until visibility improved. While waiting for the visibility to improve, the pilot, the master, and the watch mate adjusted (tuned) the ship's two radars with regard to picture display and target acquisition on the ARPA (automatic radar plotting aid) until the pilot was satisfied that the radars were performing acceptably. According to the voyage data recorder (VDR) transcript, the ship's sailing was also delayed by the need to complete some ships paperwork. About 0730, the pilot estimated that visibility had improved to approximately 1/4 mile and, according to the pilot's statement; he consulted with the master before getting underway.

About 0745, the vessel departed berth 56 with the aid of the tractor tug *Revolution* on the port quarter pulling with one line and using the ship's 2,700-hp bow thruster. The bridge navigation crew consisted of the master, the third mate, a helmsman, and the pilot. The chief mate and a lookout were on the bow, and the second mate was on the stern. After the vessel eased off the dock, the pilot had the tug shift around to the center chock on the stern as a precaution because of the reduced visibility and, as the pilot later stated, "for insurance in case I needed help in the middle of the channel." With the tug trailing behind on a slack line, the *Cosco Busan* started making headway out of the estuary.[1[1]] The dredge *Njord* was working toward the end and on the west side of the estuary, and the *Cosco Busan* passed to the right of it without incident.

The pilot stated that as the *Cosco Busan* continued to make its way out of the Inner Harbor Entrance Channel, he could see the No. 4 and No. 6 buoys pass by and noted that their lights were visible. He kept the vessel to the high side of the channel as he departed the estuary in anticipation of the flood current he would encounter. He stated that the visibility again diminished, and that he could not see the No. 1 buoy marking the northern boundary of the entrance to Bar Channel as the vessel passed by. At this time, the vessel was making approximately 10 knots.

The pilot stated that, as was his usual practice, he used the VRM (variable range marker) set at 0.33 nautical miles as a reference off the Island of Yerba Buena as he made his approach to the Bay Bridge. The pilot stated the 0.33 nautical mile distance keeps the vessel at approximately the mid-point of the bridge span between the Delta and Echo towers. As the *Cosco Busan* passed close to the No. 1 buoy off the southwest tip of the island, the pilot issued rudder orders that caused the vessel to start to come left. The ship continued to swing left, and the speed remained at about 10 knots. Shortly thereafter, the ship's heading was approximately 241°, which was almost parallel to the bridge.

[1[1]] Referring to the Oakland Bar Channel where the Inner Harbor Entrance Channel and the Outer Harbor Entrance Channel merge.

A Vessel Traffic Service (VTS) controller monitoring vessel traffic noticed that the ship was out of position to make an approach to the bridge's Delta-Echo span. The controller contacted the pilot and informed him that the automated information system (AIS) had the *Cosco Busan* on a heading of 235° and asked the pilot if his intentions were still to use the Delta-Echo span. The pilot responded that he still intended to use the Delta-Echo span and that the vessel was swinging around to the northwest with the heading showing 280°.

According the ship's master, he estimated the visibility to be very low—about 30 meters—as the *Cosco Busan* started coming right to make its way under the bridge. As the vessel continued its approach to the bridge, the pilot ordered hard starboard rudder. Shortly thereafter, the chief mate on the bow called the master via UHF radio, pointing out that the Delta tower was very close. The vessel struck the corner of the fendering system at the base of the Delta tower at approximately 0830. Immediately upon realizing the vessel had allided with the base of the tower, the pilot ordered hard to port on the rudder in an attempt to lift the stern of ship away from further impact.

Shortly afterward, the pilot radioed the VTS controllers and informed them that his ship had allided with the tower and that he was proceeding to Anchorage 7, located just west of Treasure Island, where he planned to anchor the vessel. He notified his pilot office of the incident and stated that when he saw a sheen of oil in the water at the anchorage, he immediately notified the VTS.

Another San Francisco Bar pilot relieved the pilot of the *Cosco Busan* while the ship was at Anchorage 7, and the accident pilot was tested for alcohol using a saliva strip before he departed the ship. The accident pilot was then taken to the pilot office for mandatory drug and alcohol testing. About 1002 and due to the relief pilot's concern over the vessel's draft and the water depth at Anchorage 7, the *Cosco Busan* heaved anchor and shifted to Anchorage 9, located just south of the Bay Bridge, where the vessel again anchored.

Area Map

3 GENERAL HIGHWAY/BRIDGE DESCRIPTION

Interstate (I-80) is a multilane interstate highway that is part of the Eisenhower National Highway System (NHS). It is owned, maintained, and operated by "Caltrans" (the California Department of Transportation). The bridge consists of 2 major spans (east and west) divided by an island in the center. The accident occurred on the west span. At the accident site the I-80 Bridge consisted of two five lane decks that spanned San Francisco bay. The reversible lanes are controlled by lane control signals which can also be used to progressively stop traffic in any or all lanes in either direction. Traffic controls on the facility are subject to the Manual on Uniform Traffic Control Devices (MUTCD)[2] and the Caltrans Traffic Control Manual. The ADT (average daily traffic) on the bridge is over 280,000 vehicles per day. On the day and time of the accident, the hourly traffic volume east and west bound on the bridge was about 9,000 vehicles per hour per lane. No motor vehicles were involved in this accident. The allision occurred at 0800 Local. The sun rose at 0641. Caltrans estimates that about 1,100 to 1300 vehicles were on the west span at the time of the allision. [3]

The impact occurred on Pier W-5. This nomenclature is used by Caltrans and means that it is the fifth pier west of the San Francisco end of the bridge. On NOAA and other maritime CHARTS, this pier is referred to as Pier "Delta."

Bay Bridge Looking East

3.1 CONSTRUCTION HISTORY

According to Caltrans Records, the bridge was opened to traffic November 12, 1936. The bridge consists of two major spans connecting each shore with Yerba Buena Island, a natural

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[2]The Federal Highway Administration, as the standard for all streets and highways in accordance with Title 23, U.S. Code, Sections 109 (b), 109 (d), 402 (a) and 23 CFR 1204.4, approved the MUTCD.

[3] This data came from Caltrans' continuous traffic data sensors on the bridge.

island located mid-bay. The western crossing, from San Francisco to the island, consists of two suspension bridges end-to-end with an anchorage, plus three shorter truss spans connecting the San Francisco landing to the western cable anchorage located on Rincon Hill. The eastern span between Yerba Buena Island and Oakland consists of a double-tower cantilever span five medium-span truss bridges, and a 14 section truss causeway.

3.1.1 DESCRIPTION OF THE FENDERING SYSTEM

A bridge tower fendering system was installed as part of the original bridge construction in 1936. The following statement is contained in the bridge's final design report from the 1930's as provided by Caltrans:

> "The fender system at the Bay Bridge was installed in 1936 as part of the original construction of the bridge. It is a robust system consisting of a concrete skirt and timber walers and sheathing. Since the size of the pier precludes any possibility of damage to it by a colliding ship, the fenders were designed so as to inflict a minimum of damage on the ship. The timber work on the outside would ward off any ordinary blow. Should the ship crash through this and strike the concrete with enough force to puncture the hull, the hole would be above the water line and there would be less danger of it sinking".

Caltrans states further:

> "*While the fender system has had little change in the past 70 years, the actual bridge piers, along with the rest of the structure have undergone an extensive seismic retrofit in the past decade, designed to withstand the forces of a maximum creditable earthquake here in the San Francisco Bay Area (8.0 magnitude) with minimal damage to the bridge.*"

The most recent work on the damaged fender system involved replacing the wood timbers with recycled plastic lumber. At the time of the allision, the upper fending system of the Delta tower consisted of five layers of wood timbers. The wood timbers of the lower system had been replaced with recycled plastic in 2006.

Differences exist between the fenders on some of the piers that, according to Caltrans, resulted from routine maintenance, up-grades and repairs over the life of the bridge. However, the overall performance of all fenders met the 1991 AASHTO design requirements. They stated that pier 5, the accident pier, functioned as designed to protect the pier from structural damage during the allision. The fenders are designed to absorb the energy from an allision, sacrificing the fender system to protect the pier.

Caltrans is re-evaluating the fender systems and will be considering new fender designs that might better protect the bridge and its elements. Caltrans is in contact with the U.S. Coast Guard, U.S. Navy, the Federal Highway Administration (FHWA) and several other State Departments of Transportation regarding their practices and the status of any ongoing fender system research. They have also contacted various manufacturers of fender system products. The design of the accident fender system for the W5 pier (Delta) appears to be essentially the same as the design shown in the current AASHTO 1991 guide.

3.1.2 DAMAGE TO THE FENDERING SYSTEM

Following the allision, Caltrans maintenance crew on site estimated that approximately 100 feet of the fender system and skirt were damaged at the southeast corner of Pier W5, but found no damage to the bridge structure. The final cost of repairing the fendering system was $1.5 million.

3.2 Bridge Design Guidelines and Specifications

Below is a list of the applicable AASHTO design guides for bridges since 1927:

- *Standard specifications for Highway Bridges and Incidental Structures dated July 1927*
- *Guide Specification and commentary for vessel collision design of highway bridges – Volume I : Final Report February 1991*[4]
- *Guide Design Specifications for Bridge Temporary Works 1995*
- *Standard Specifications for Bridges, Sixteenth Edition 1996*
- *Guide Specifications for Seismic Isolation Design 1999*
- *Standard Specifications for Bridges, Seventeenth 2002*

The 1927 design guide, applicable at the time this bridge was constructed did not require or mention pier protection from errant vessels. The AASHO document did specify protection for structures from floating materials and ice packs. However, pier protection fenders were included for the Bay Bridge in the original construction project. Since then periodic maintenance or modifications have been made to the fenders and the bridge structure when necessary or as new technology evolved.

According to Caltrans the design of the accident fender system for the W5 pier (Delta) complies with the current AASHTO 1991guide.

Because of security concerns, Caltrans was unable to share detailed information about the structural integrity of either the fendering system or the piers. The actual bridge design plans, specifications and their revisions are classified “confidential” by Caltrans and the US Department of Home Land Security (DHS).

1.2 HIGHWAY BRIDGE DESIGN BACKGROUND

The information below is from AASHTO’s 1991 *Guide Specification and commentary for vessel collision design of highway bridges* and provides a good background on this history of bridge protection: It describes the design provisions for bridges crossing navigable waterways to minimize their susceptibility to damage from vessel collisions. It states that the purpose of these provisions is to provide bridge components with a reasonable resistance capacity against vessel

[4] The “*Guide Specification and commentary for vessel collision design of highway bridges – Volume I: Final Report February 1991” is cited in the later manuals for use where bridge structures a subject to being struck by ships or other vessels .This document is currently being re-written to include new technology and practices.*

collision, recognizing that these provisions should not be interpreted as covering all conceivable cases of vessel collision.

> "The 1980 collapse of the Sunshine Skyway Bridge crossing Tampa Bay in Florida was a major turning point in the development of vessel collision design criteria for bridges in the United States. As a result of the collision by an empty 35,000 DWT bulk carrier with one of the bridge's anchor piers, 1,300 feet of the southbound main span collapsed and 35 lives were lost in vehicles which fell into the bay. In the period 1965-1989, an average of one catastrophic accident per year involving bridge collisions by merchant vessels have been recorded worldwide. More than 100 persons died in these accidents and very large economic losses were incurred in repair/replacement costs, lost transportation service, and other damages. More than half of these bridge collisions occurred in the United States."
>
> "As a result of this accident, increased concern over the safety of bridges crossing navigable waterways has arisen and research into the vessel collision problem has been initiated in several countries of the world. In 1983, a "Committee of Ship/Bridge Collisions" appointed by the Marine Board of the National Research Council, Washington, D.C. examined the risks and consequences of ship and barge collisions with bridges in the United States. Included in this committee's report were the following observations:
>
> - No agency or unit of government is responsible for the safety of over water bridges against ship collisions.
> - No standards have been developed for the design and construction of bridges to resist ship collisions (with the exception of criteria for fenders to protect railroad bridges).
> - Regulatory and institutional activities address parts of the ship-bridge-waterway system, but none addresses the functioning of the system as a whole.
>
> "In 1988, a pooled-fund research project sponsored by 11 states and administered by the Federal Highway Administration (FHWA) was initiated to begin addressing the above concerns by establishing a design specification for ship and barge collisions with highway bridges crossing navigable waterways. The basis of the project was the published literature from the "*1983 Colloquium on Ship Collisions with Bridges and Offshore Structures*" held in Copenhagen, Denmark by the International Association of Bridge and Structural Engineers (IABSE), and the results of in-depth ship collision studies performed for several bridge projects by consultants worldwide.[5]
>
> "Development of the Specification has been predicated on the following basic concepts:
>
> - Hazard to life be minimized
> - Risk of bridge service interruption to be minimized
> - Importance of bridge to be reflected in required safety level
> - Specifications to accept damage of secondary structural members provided bridge service can be maintained
> - Specifications to be simple and unambiguous

[5] *Guide Specification and Commentary for Vessel Collision Design of Highway Bridges,* AASHTO February 1991.

- Ingenuity of design not to be restricted
- Provision to be applicable to all of the United States"

3.3 Vulnerability of Bridges to Vessel Collision – Risk Assessment

Prior to the 1990's, Caltrans based the vessel collision risk management on the large navigational channel (2200 feet) and the preventive measures in place including navigational lights, radar guidance beacon in centerline of channel, US Coast Guard tracking vessel traffic, and the use of qualified harbor pilots. After approximately 1991, Caltrans has used Method II from page 22; section 4 of the 1991 AASHTO document

According to Caltrans, Method II is a more complicated probability-based analysis procedure for selecting the design vessel for evaluating possible vessel collisions. Method II basically categorizes bridges in to "critical/essential bridges" and "typical bridges" and assigns a probability with an acceptable annual frequency of collapse. The acceptable annual frequency of collapse in 1 in 10,000 years for critical bridges and 1 in 1,000 years for typical bridges.

In calculating the acceptable annual frequency of collapse AASHTO includes several factors including vessel exposure data and the probability of vessel aberrancy. AASHTO views vessel aberrancy as usually the result of pilot error, adverse environmental conditions, or mechanical failure. Examples of these factors are listed below:

1) Human Errors:
   - Inattentiveness on board the ship
   - Lack of reactivity (drunkenness, tiredness)
   - Misunderstanding between captain/pilot/helmsman
   - Incorrect interpretation of chart or notice to mariners
   - Violations of rules of the road at sea
   - Incorrect evaluation of current and wind conditions, etc.
2) Mechanical Failures:
   - Mechanical failure of engine
   - Mechanical or electrical failure of steering
   - Other failures due to poor equipment, etc.
3) Adverse Environmental Conditions:
   - Poor visibility (fog, rainstorm)
   - High density of ship traffic
   - Strong current or wave action
   - wind squalls
   - Poor navigation aids
   - Awkward channel alignment, etc.

The risk analyses also takes into consideration the width/depth of the waterway, the number and width of pier and span elements located within the waterway, or within a certain distance on each side of the inbound and outbound vessel transit paths. This results in an acceptable risk criterion for each pier and span element of the total bridge.

3.4 BAY BRIDGE ACCIDENT HISTORY

Repair records by Caltrans documented seven occasions when vessel strikes necessitated repairs to the fendering system of one of the Bay Bridge piers. In each case, the damage was only to the wood sheathing, with repair costs ranging from $10,000 to $50,000. Two of these strikes involved the Delta tower. The first strike to the tower involved the USS Gardiners Bay, a 2592 ton Barnegat class small seaplane tender that allided with the tower on February 14, 1957. The second strike, which was the last strike before the Cosco Busan allision, involved the vessel Brilliant Star in February 1980 and resulted in damage to the fender's wood sheathing. No information was found on the size of that vessel or the circumstances of that incident or the one involving the USS Gardiners Bay. Other strikes to other bridge piers included a tugboat, a barge, and other vessels that were not identified.

There were also plane strikes in the 1950's and 1960's.

The information below was provided by Caltrans:

Contract Date	**Location**	**Reason**
October 1956	Pier W5	Damage to wood sheathing due to vessel impact. Collision date Feb 14, 1957 by the USS "Gardiners Bay"
August 1961	Piers W2-W6	General routine repairs
May 1964	Pier W3, NE Corner	Damage to exterior sheathing, presumed minor vessel collision (no data)
July 1967	Pier W4, South Corner	Damage to exterior sheathing, presumed minor vessel collision (no data)
August 1969	Pier W3, South Face	Damage to wood sheathing due to vessel impact. Collision date Nov 7, 1968 by tugboat (no name on record) owned by Red Stack Tugboat Co.
September 1970	Pier W3, NE Corner	Damage to wood sheathing due to vessel impact. Collision date Nov 22, 1969 by "Barge #18" Standard Oil Company
March 1974	Pier W3, SW Corner	Damage to exterior sheathing, presume minor vessel collision (no data)
July 1982	Pier W5, NE Corner	Damage to wood sheathing due to vessel impact. Collision date Feb 29,1980 by the "Brilliant Star"
February 1991	Piers W4-W6	General routine repairs
January 2006	Piers W2-W6	Rehabilitation
December 2008	Pier W5, SE Corner	Damage to sheathing and concrete skirt due to vessel impact. Collision date Nov 7, 2007 by the container ship Cosco Busan.

In all of the incidents, damage was found to have been minimal and limited to the wood sheathing of the fender.

3.5 SEISMIC STRUCTURAL IMPROVEMENTS TO BAY BRIDGE

The entire Bay Bridge (and others in the State) was equipped with seismometers and other instrumentation to detect and measure abnormal movement of the bridge. This was a part of Caltrans' response to the loss of several bridges in the 1989 Loma Prieta and the 1994 Northridge earthquakes. Several major bridge structures collapsed during that event. The system allows Caltrans to evaluate any movement of the structures and react as necessary.

When mathematically modeling the West Spans of the Bay Bridge for seismic loads during the retrofit design process, Caltrans used peak spectral accelerations as high as 1.4g and analyzed pier displacements in the 18 to 24 inch range. The Bay Bridge sensing system detected the allision of the *Cosco Busan* with Pier W5. The impact moved the pier 0.117cm = 0.046 inches (just under 3/64 of an inch) at the pier. Top of the steel tower moved 0.17cm = 0.066 inches. Duration of impact was approximately 16 seconds. The ship allision showed a maximum lateral acceleration of 0.018g at the tower leg base and 0.058g at the top of the tower. Caltrans engineers said that the movement was insignificant and equal to the movement that the tower might regularly experience on a windy day[6]. The accident initiated pier movements were determined by Caltrans to be too small to warrant closure of the bridge to traffic. The bridge was inspected immediately after the allision and it was found that all damage was limited to the fender[6].

3.6 Caltrans Actions Following the Allision:

Caltrans furnished the following description of their actions following the allision:

> "Following the collision of the *Cosco Busan* with the protective fender system around the Bay Bridge pier, California Department of Transportation (Caltrans) Structure Maintenance & Investigations engineers visually inspected the damage and followed up with a review of the data from seismic monitoring devices on the bridge. The visual inspection confirmed that the protective fender system performed as intended – to protect the bridge from collapse from allision."

The following timeline was developed based on information furnished by Caltrans and through other sources:

8:47 a.m.	The USCG Vessel Traffic Service center notified the Area Emergency Response Center, and at 8:47, the Area Emergency Response Center notified Caltrans.
9:00 a.m.	Office Chief, Caltrans Structures Maintenance & Investigations (Toll Bridges) received a phone call from (Caltrans Toll Bridge Maintenance Operations Manager), requesting that an engineer accompany the Maintenance crew on a boat to the incident site.
9:10 a.m.	Senior Bridge Engineer, SMI) assigned Area Bridge Maintenance Engineer) and Transportation Engineer inspected the pier for damage.
9:45 a.m.	Maintenance crew supervisor on a Boston Whaler to Pier W5 to inspect damage.
Approx. 9:45 a.m.	The initial on scene inspection reports of the seismic readings were transmitted to the Emergency Response Center
11:15 a.m.	Caltrans Toll Bridge Maintenance Operations Manager received update from maintenance crew and engineers at site that there was approximately 100± ft of damage to the fender system and skirt at the southeast corner of Pier W5, but no damage to the bridge structure. Caltrans Maint. Specialty Region confirmed that the navigational lights, raycon, and fog horn are operational. The ship is being detained west of Treasure Island, and is identified as the Cosco Busan.

[6] Information provided by the Caltrans Bay Bridge maintenance engineers.

In addition, the Board learned from interviews that at approximately 9:45 the initial on scene inspection reports of the seismic readings were transmitted to the Emergency Response Center.

3.7 Federal Highway Administration Oversight

Because the Bay Bridge is a part of the Eisenhower National Highway System (NHS) as I-80, the Federal Highway Administration has oversight for the Bay Bridge system. According to the FHWA, it is ultimately responsible for ensuring financial integrity and compliance with applicable federal laws and regulations, regardless of approval authority or responsibility delegated to Caltrans. FHWA further describes this relationship as follows:

> "Projects for which defined approval authority is delegated to Caltrans are not subject to further approvals by the FHWA, unless it is jointly agreed. However, the FHWA reserves the right to perform reviews of all programs and projects at any time, while maintaining a focus on efficient project delivery. The reviews may include projects or programs with unique features, high-risk elements, unusual circumstances, and those included in process reviews."

3.8 Bridge Inspections

The FHWA is responsible for administering the national bridge inspection program, which consists of national bridge inspection standards (NBIS) and a national bridge inventory (NBI). The national bridge inspection standards (NBIS) were first established in 1971 to set national requirements regarding bridge inspection frequency, inspector qualifications, report formats, and inspection and rating procedures. The national bridge inventory (NBI) is the aggregation of structure inventory and appraisal data collected by each state to fulfill the requirements of the program. The structure inventory data consists of fields that include identification of the bridge, structure type and material, age and service, geometric data, navigation data, and classification. The structure appraisal data consists of fields that include condition, load rating and posting, appraisal, proposed improvements, and inspections.

The national bridge inspection program requires bridges be inspected at regular intervals not to exceed 24 months.

The last inspection was completed in March 2007. Its sufficiency rating was categorized in that inspection as "Structurally Deficient". Bridges are classified as structurally deficient if one or more components such as the deck, superstructure, substructure or culvert have a general condition rating of 4 or less, or if the road approaches are regularly susceptible to flooding. A general condition rating of 4 means that the component rating is described as poor. Examples of poor condition include corrosion that has caused significant section loss of steel support members, movement of substructures, or advanced cracking and deterioration in concrete bridge decks. For bridge owners, the classification structurally deficient is a reminder that the bridge may need further analysis that may result in load posting, maintenance, rehabilitation, replacement or closure.

A structurally deficient bridge typically needs maintenance and repair and eventual rehabilitation or replacement to address deficiencies. To remain open to traffic, structurally deficient bridges can be posted, if required, with reduced weight limits that restrict the gross weight of vehicles using the bridges. If unsafe conditions are identified during a physical inspection, the structure is closed.

3.9 BAY AREA EMERGENCY ACTION PLANS

The Bay area has an extensive Emergency Action Plan that includes delineation of agency responsibilities and checklists. They also have personnel, facilities, equipment and materials to address an emergency. When an emergency situation occurs, the Emergency Response Manager will be notified immediately by the Duty Officer, or by other staff reporting the emergency. The Emergency Response Manager is responsible for immediately assessing the severity of the emergency and determining the level of response and activation of the Emergency Response Center (ERC). Responses have been divided into three levels.

The first level (Level I) involves emergencies considered to be routine and do not require activation of the Emergency Response Center (ERC). Examples are: vehicle accident blocking highway; Hazmat spill isolated to small area, trees down across roadway, or small slides or slip-outs.

The second level (Level II) involves emergencies of moderate size and not wide spread in nature. The ERC may be activated but this level of emergency would likely not require the full resources of the entire ERC. Examples are: Major hazardous materials spill requiring road closure and evacuation; road closure due to large slide or slip-out; localized flooding or other storm damage; minor earthquakes; heavy winter snow fall and icing conditions causing road closures; or wild lands fires. Emergency response may be down graded to a Level I response after full assessment of the nature and extent of the emergency.

The third level (Level III) involves emergencies that require the immediate activation of the full ERC staff. All functions will immediately report to the ERC site and will begin to activate their appropriate support staff. Staffing is expected to be on a 24 hour basis. Examples are: major earthquakes; regional flooding and storm damage. Emergency response may be down-graded to a Level II or I response, after full assessment of the nature and extent of the emergency."

Caltrans participates in this program and utilizes emergency action checklists for a major earthquake and other emergencies. These checklists include the types of actions that would be taken should an event occur requiring the closure of the bridge.