



# Measuring Cat Exposure in the Energy Space Energy Transmission Catastrophes

OCTOBER 4, 2012

**Session MAN-4**

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# Energy Transmission Catastrophes

## Introduction

- Energy transmission and distribution can result in man-made catastrophes that are only now being fully recognized
- No doubt, some potential catastrophes are not yet contemplated
- Two types that have already demanded more appreciation:
  - Natural gas pipeline ruptures
  - Wildfires ignited by electrical power lines

# Natural Gas Pipeline Ruptures



# Natural Gas – Pipeline Ruptures

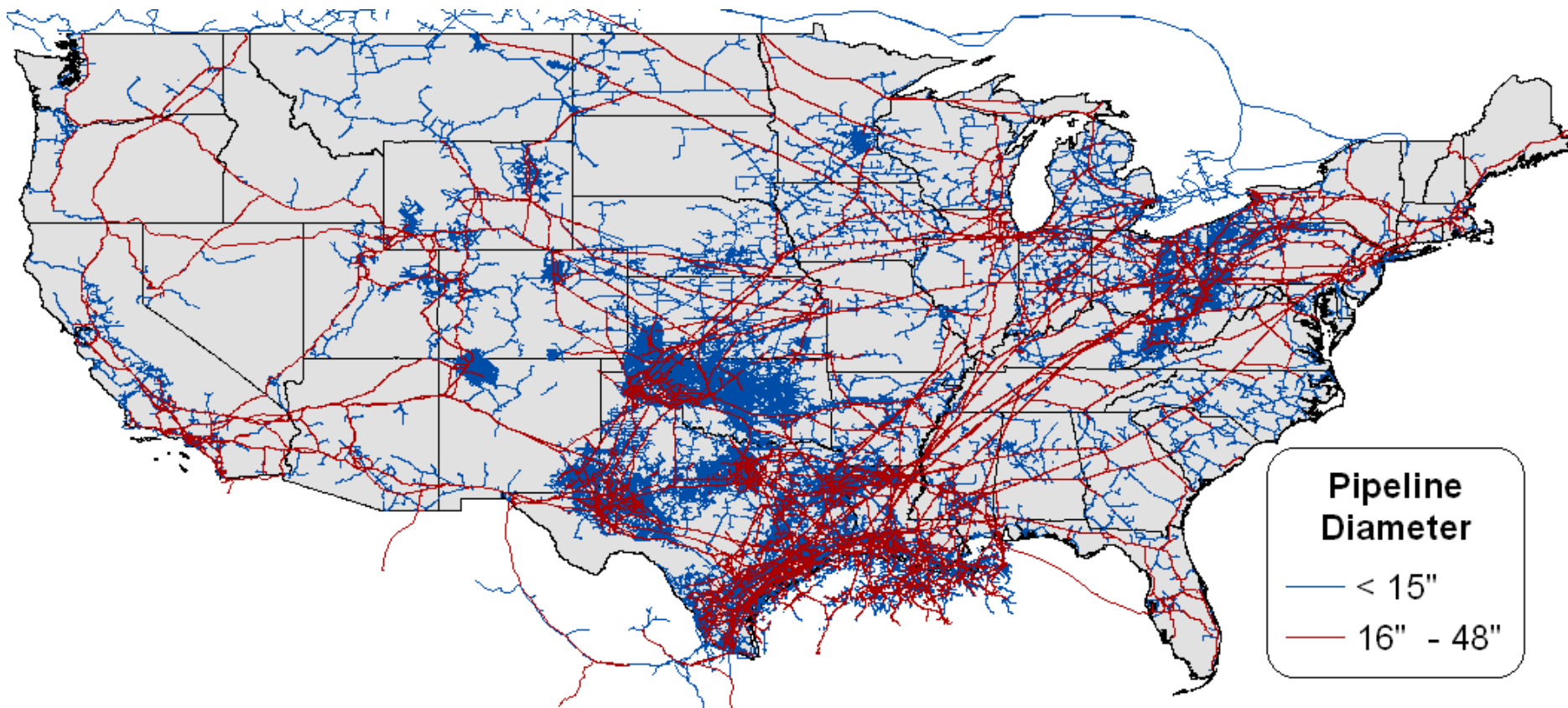
## Pipeline Basics

- Energy transportation network of the United States consists of over 2.5 million miles of pipelines
  - 321,000 miles of onshore and offshore Gas Transmission and Gathering pipelines
  - 2,066,000 miles of Gas Distribution mains and service pipelines
- Natural Gas Pipeline Systems:
  - **Gathering** systems gather raw natural gas from production wells
  - **Transmission** systems transport material thousands of miles across the continental US
  - **Distribution** systems distribute natural gas to homes and businesses through mains and service lines
  - Pipeline Size: usually 2 to 42 inches in diameter (except for service lines which are ½ to 2 inches in diameter)
  - Pipeline Material: cast iron, steel, copper and plastic

*Pipeline & Hazardous Materials Safety  
Administration (PHMSA)*

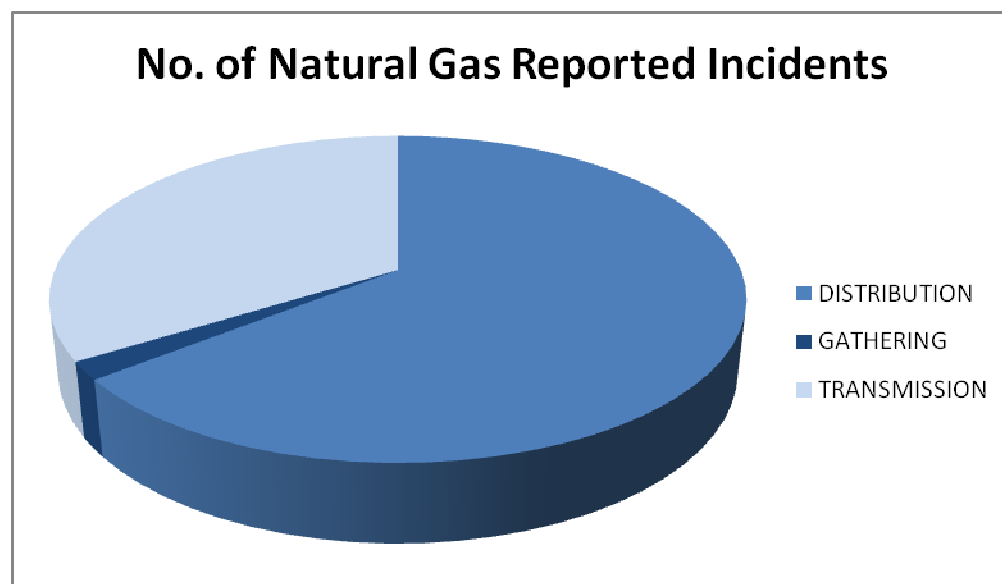


# Natural Gas – Pipeline Ruptures Map



## Natural Gas – Pipeline Ruptures PHMSA Natural Gas Pipeline History

Pipeline Systems	Records	Fatalities	Injuries	Dollar Loss	% of Count
DISTRIBUTION	3,607	404	1,728	\$ 1,995,526,711	64.4%
GATHERING	100	3	22	\$ 45,938,992	1.8%
TRANSMISSION	1,894	52	287	\$ 1,967,740,669	33.8%
<b>Total</b>	<b>5,601</b>	<b>459</b>	<b>2,037</b>	<b>\$ 4,009,206,372</b>	<b>100%</b>



- Reported incidents are for natural gas pipelines only during the years 1986 – March 2012 as provided by the PHMSA raw data
- Dollar Losses were adjusted for inflation by PHMSA

## Natural Gas – Pipeline Ruptures An Increasing Hazard

*"Nationally, the number of major failures on high-pressure natural-gas pipelines climbed 50% in the last decade, while the number of miles of such pipe increased less than 5%, according to federal data."*

*"Accidents caused by people inadvertently digging into pipelines have decreased 43% over that time; those caused by the failure of pipeline materials have nearly quadrupled."*

*According to US PHMSA "current models companies use are 'ineffective to analyze the risks' posed in a combination of threats" and the regulator is now stepping up pressure on companies to manage pipeline risks.*

*The Wall Street Journal*

# Natural Gas – Pipeline Ruptures

## San Bruno Pipeline Rupture, 2010

- San Bruno explosion and fire - September 2010
  - 30-inch diameter pipeline ruptured in a residential area 2 mi from SFO Int'l Airport
  - Explosion created a crater approximately 72 feet long by 26 feet wide
  - Subsequent fire destroyed 37 homes and damaged 18 more
  - Eight people were killed, numerous individuals were injured, and many more were evacuated from the area





## Natural Gas – Pipeline Ruptures February 9, 2011 – Allentown, PA



- 5 people killed and 8 homes were destroyed in explosion
- Cause was reported as 12” crack in 84 yr old cast iron main
- This occurred after warnings about replacing old cast iron gas mains
  - Warnings were in response to an explosion in 1990
  - From 1990 to 2006 there were four explosions from cast iron mains owned by the same operating company that resulted in:
    - At least 2 people killed and many others injured
    - Multiple homes were also destroyed or damaged
- In 2012 the operating company was cited and fined for multiple safety violations such as failure to keep up appropriate facilities and failure to properly use safety tests weekly and follow emergency procedures.

## Natural Gas – Pipeline Ruptures Risk Quantification

- Report:
  - “A MODEL FOR SIZING HIGH CONSEQUENCE AREAS ASSOCIATED WITH NATURAL GAS PIPELINES”
  - Performed by C-FER Technologies
    - On behalf of the Gas Research Institute
    - October, 2000
  - Purpose:
    - *“To develop a simple and defensible approach to sizing the ground area potentially affected by the failure of a high-pressure natural gas pipeline.”*
- Hazard radius
  - Largest, highest-pressure pipelines: ~ 1,200 feet
  - Thermal only (not flash fire, conflagration, blast, projectiles, lateral jets, wind, etc.)

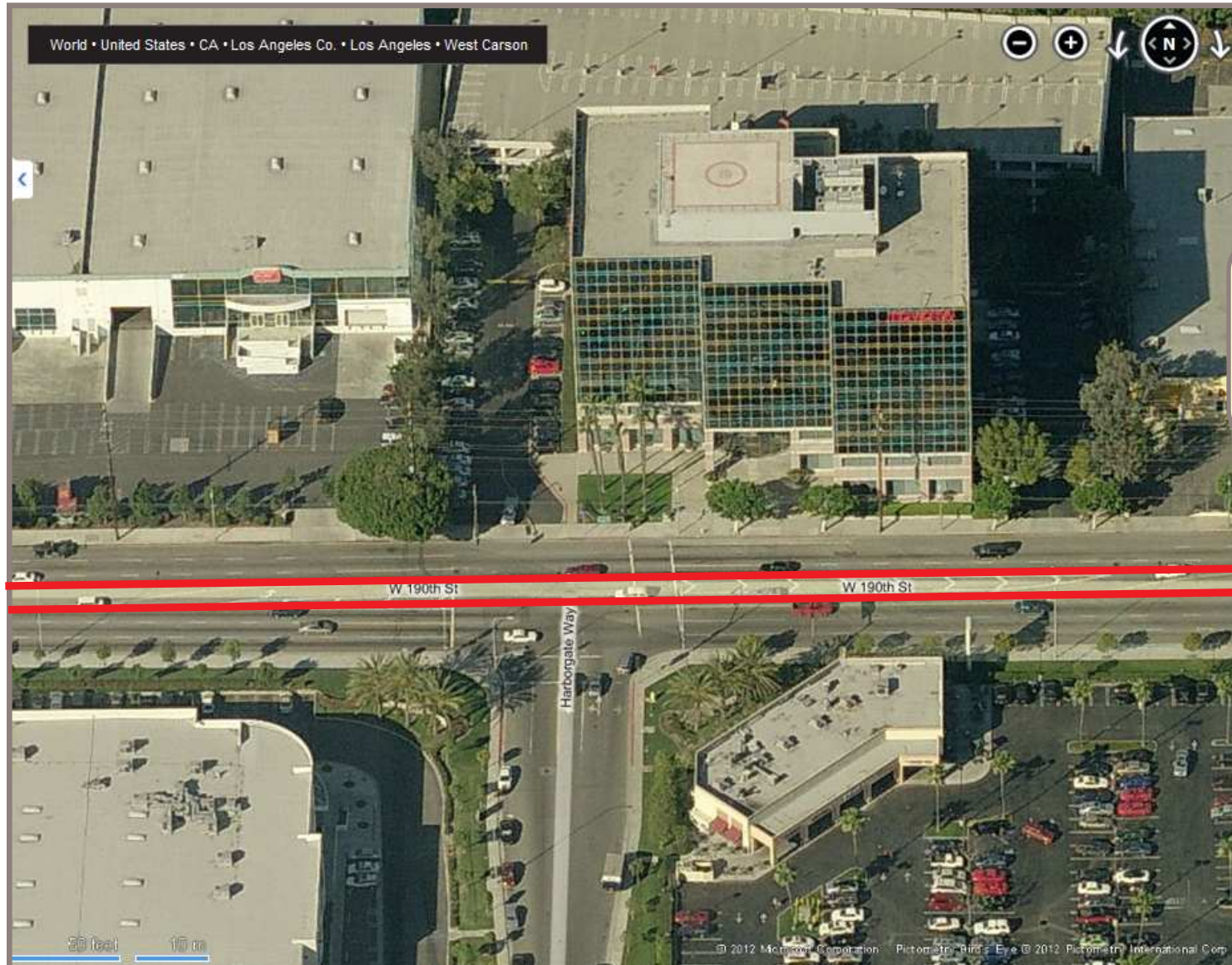
## Natural Gas – Pipeline Ruptures Example – Residential Area near Large Pipelines



Three natural gas  
pipelines:  
42", 36", 30"

# Natural Gas – Pipeline Ruptures

## Example – Commercial Area near Large Pipelines



Two 30”  
Pipelines

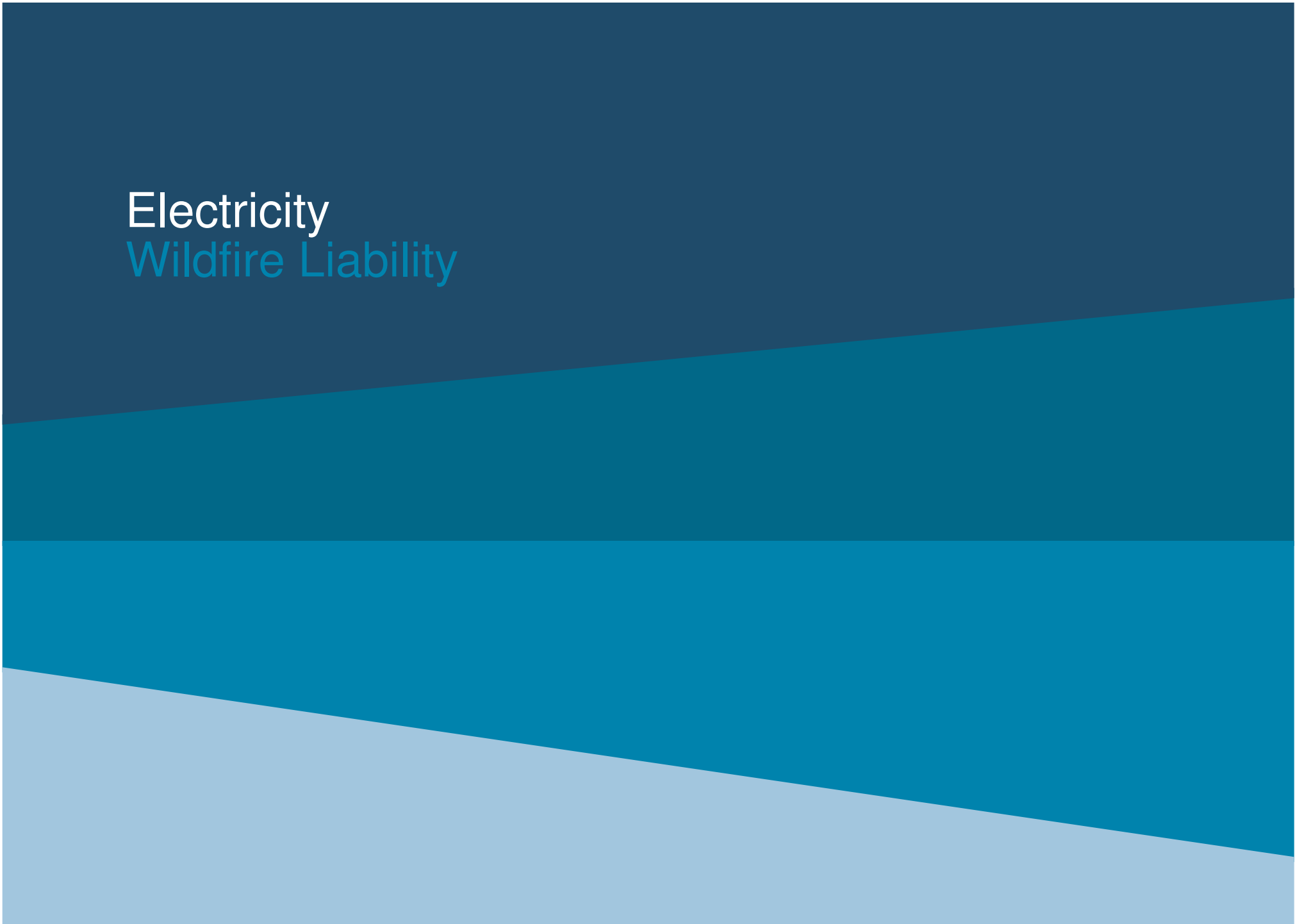
*Bing Maps*

## Natural Gas – Pipeline Ruptures

### Loss Potential

- Property losses
- Casualties
- Business interruption, supply chain interruption, additional living expenses
- Transportation, energy, communications damage and disruption
- Fire-fighting costs
  
- Liability?
  - Earthquake?
  - Terrorism?

Electricity  
Wildfire Liability



## Electricity – Wildfire Liability Background

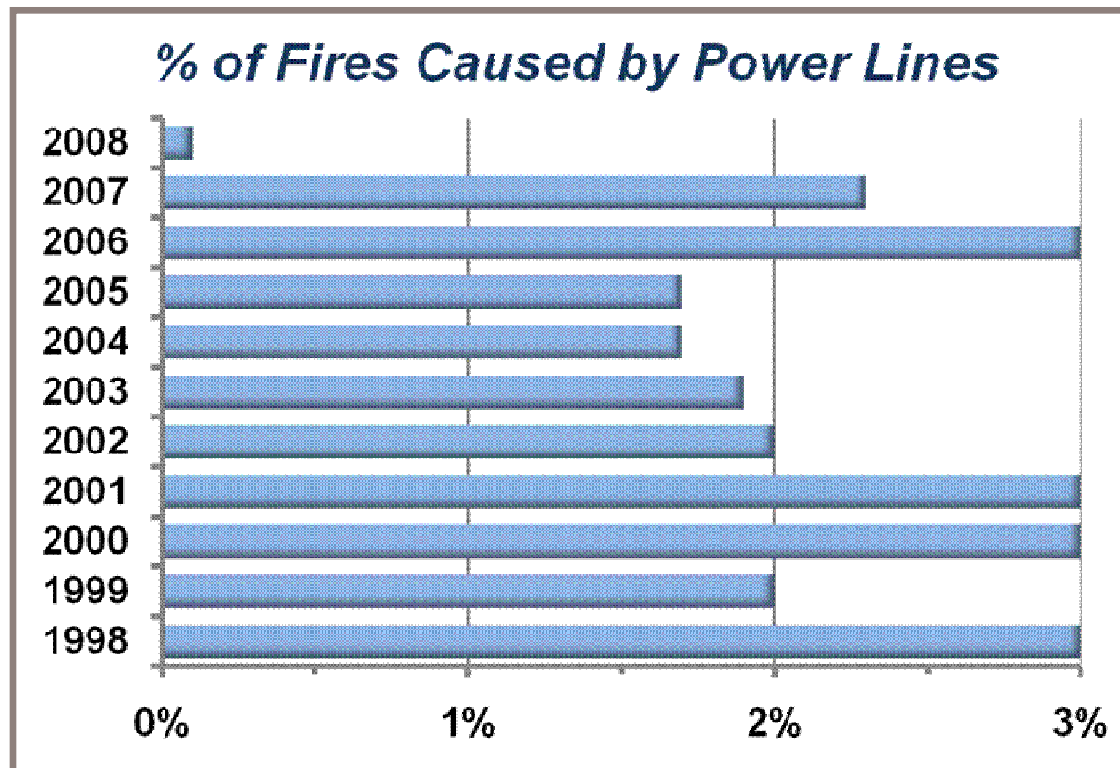
- Electrical power lines
  - Transmission
  - Distribution
- 1990's growing concern:
  - Electromagnetic fields
    - Health effects
    - Diminished property values
    - Still developing
- 2007 Southern California wildfires
  - Wildfires caused by power lines



## Electricity – Wildfire Liability

### California Wildfires Caused by Power Lines

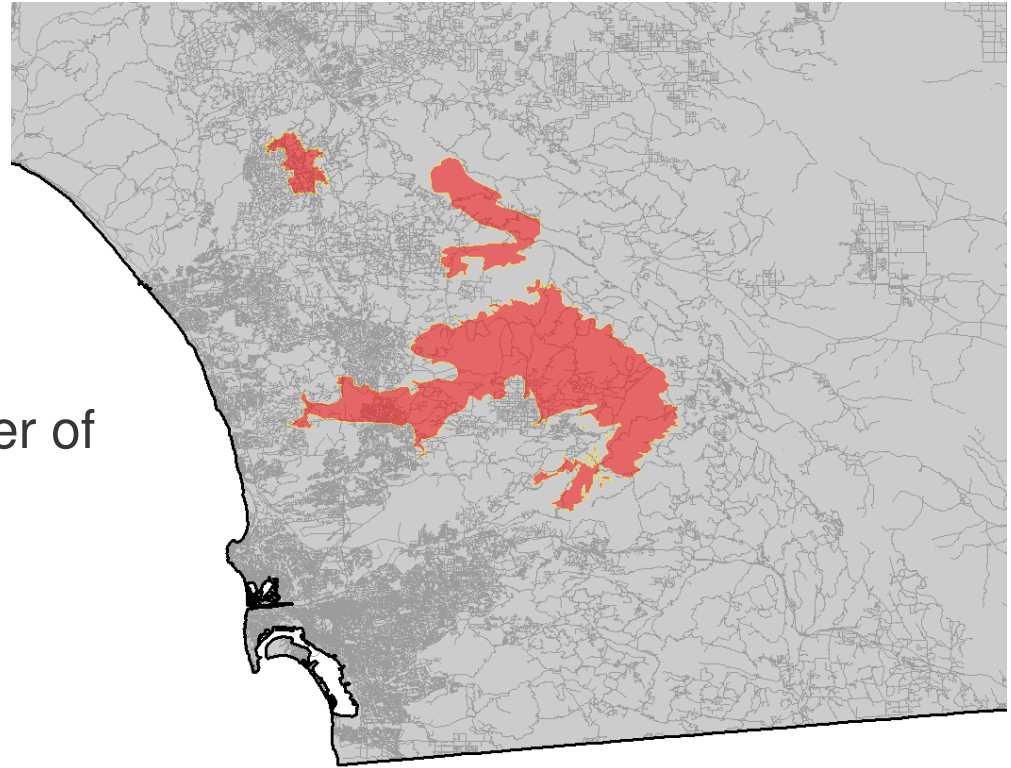
- On average, power lines cause about 2% of wildfires in California
- Varies by year and Santa Ana conditions
- In the Santa Monica Mountains, power lines sparked 8% of the fires since 1981





## Electricity – Wildfire Liability Southern California Wildfires of 2007

- Fall of 2007, Southern California
  - Santa Ana winds drive a cluster of wildfires
    - 10 lives lost
    - 3,000 structures destroyed
    - Over 500,000 acres burned
    - Power, water, and telecommunication disruptions



*CAL FIRE, OES, US Forest Service*

## Electricity – Wildfire Liability Conclusions

- Cal Fire and Public Utilities Commission determination:
  - SDG&E power lines caused three of the worst fires
    - Witch Creek, Guejito, and Rice Canyon
- Claims ~ \$1.5 billion
- Essentially strict liability?
  - \$700 million settlement
- Effects on energy insurance and reinsurance
  - Reduced capacity
  - Increased premium
  - Wildfire liability now separate from general liability

*U-T San Diego News*  
5/5/2009

## Other Energy Risks Examples

- Oil
  - Enbridge oil spill – July 2012
- Cyber risk
  - Saudi Aramco Oil computer virus attack – August 2012
  - RasGas in Qatar – August 2012
  - Catastrophe potential?
- Solar superstorm
  - National power grid could be out for a year
  - \$2 trillion in losses
  - “Carrington event” of 1859

*National Academy of  
Sciences (NAS)*



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