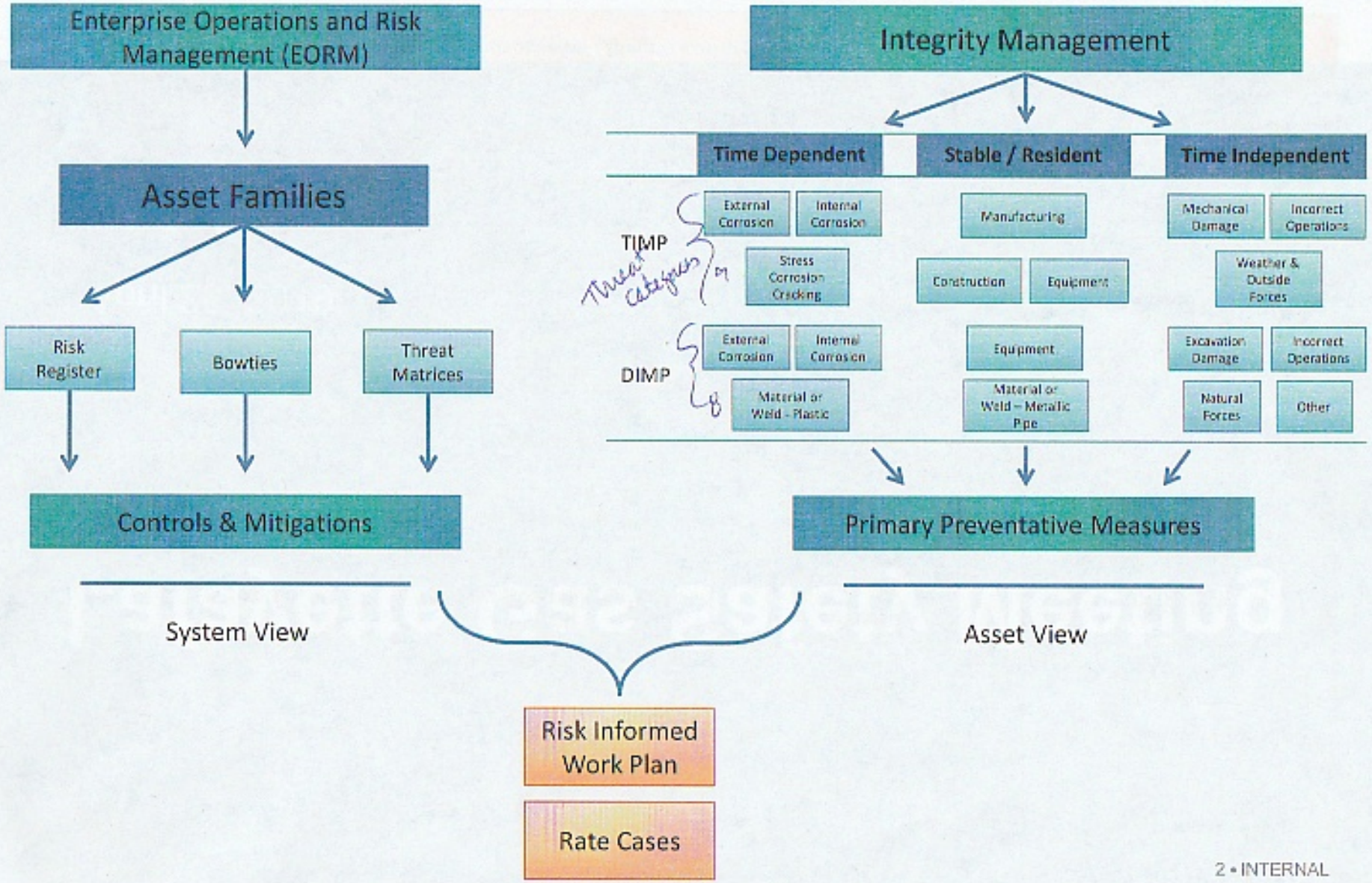
Lafayette Gas Safety Meeting

April 25, 2019

Together, Building
a Better California

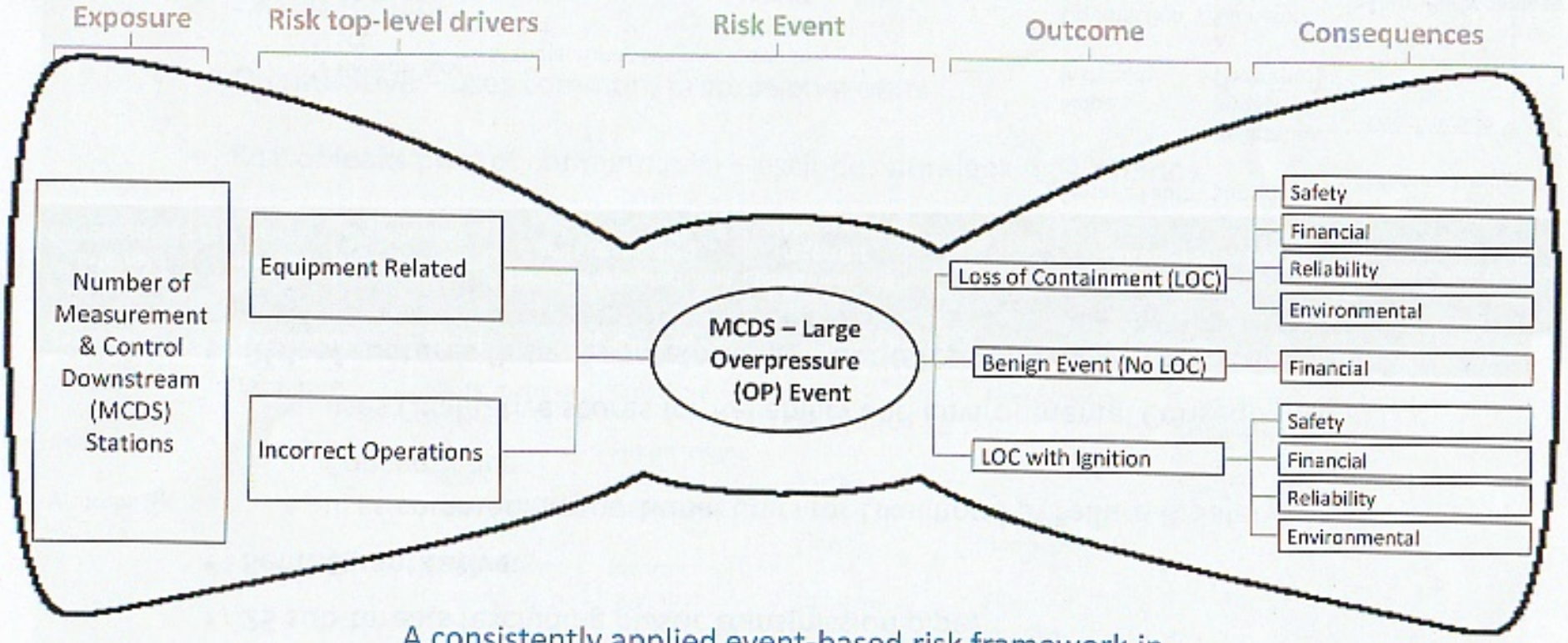
Enterprise and Integrity Management Risk Views



Event-Based Risk Framework Overview

Bowtie analysis helps us understand:

- Risk drivers and the controls to reduce their frequency
- Risk consequences and the controls to reduce their impact



A consistently applied event-based risk framework in conjunction with data-driven risk modelling supports:

- Mutually-exclusive risks where risk models do not overlap
- Visibility to drivers and controls that impact multiple risks
- Ability to prioritize controls based on comprehensive view of impact and effectiveness

Transmission Pipe Risk Model

- **1 million** dynamic segments
- **25** sub-threats (excluding plastic transmission pipe)
- **Semi-Quantitative:**
  - uses common, proportional units for Likelihood of Failure & Safety Consequence
  - uses Qualitative scores for Reliability and Environmental Consequence
- **Risk of ruptures (loss of containment) – excludes non-rupture scenarios**

Steel Pipe External Corrosion (EC)	Steel Pipe Internal Corrosion (IC)	Steel Pipe Stress Corrosion Cracking (SCC)	Steel Pipe Manufacturing and Construction	Steel Pipe Equipment and Incorrect Operations	Steel Pipe Third-Party Damage (TPD)	Steel Pipe Weather-related and Outside Forces (WROF)		Plastic Pipe threats
External Corrosion	Internal Corrosion	High-pH Axial SCC Near Neutral-pH Axial SCC Circumferential SCC	Manufacturing Seam defect Manufacturing Body defect Construction defect	Over-pressure due to Equipment Failure Over-pressure due to Incorrect Operations	Excavation Damage	Seismic Fault Crossing Slope Instability Liquefaction Erosion Lightning Frost Heavy Rain or Floods	Subsidence Vegetation Impact (Tree root) Tsunami Wind Impact Vehicular Damage Vandalism Arc Strike	Manufacturing Construction Equipment Third-Party damage Incorrect Operations Weather-related and Outside Forces (WROF)

Distribution Risk Model Overview

- **8 million** segments and service points
- **29** sub-threats
- **Quantitative** – uses common, proportional units
- Risk of **leaks** (loss of containment) – excludes non-leaking scenarios
- **Safety** – the key consequence factor used

Corrosion	Excavation	Material & Weld	Incorrect Operation	Natural Force	Other Outside Force	Equipment Failure	Other
Internal	Excavation	Plastic material failure	Crossbore	Earth Movement	Fire/explosion	Equipment malfunction	Other
External		Metallic material failure	Fusion failure	Earthquake	Rodents	Pipe Dope	
Atmospheric		Compression coupling	Weld failure	Flood	Previous damage		
			Incorrect operation	Lightning	Electrical facilities		
			Construction defect	Root damage	Third party		
				Tsunami	Vandalism		
				Other natural forces	Vehicle		

Threat Matrix (Transmission Pipe)

Approved: 07/17/18

	Primary Causes of Failures		Primary Prevention Measures (highest impact on risk reduction - from left to right)
Time Dependent Threats	External Corrosion TRA1	• Inadequate coating • Inadequate CP • Corrosive Environment • DC/AC Interference • Seal water/ice inundation • Interacting third party damage	Cathodic Protection; Pipe Coating; Electrical Interference Program (DC); Atmospheric Corrosion Inspection Program; Electrical Interference Program (AC); Casing Monitoring; ILI; ECDA; GSR/SCADA Program (Non-PCA); CPSI (EC + ARDF); Assessment Pressure Test; Leak Survey; Public Awareness & Damage Prevention (EC + PD)
	Internal Corrosion TRA8	• Poor gas quality • Water intrusion	Gas Quality; ILI; Operational Pigging; Internal Corrosion Site Specific Plans (i.e. Sampling/MDE); ICDA; Assessment Pressure Test; Leak Survey
	Stress Corrosion Cracking TRA9	• High operating temperature • High operating/residual stress • Mechanical Damage • Hard Spots • CP in SCC voltage ranges • Pressure cycling	Pipe Coating; Assessment Pressure Test; ILI; SCCDA; Discharge Temperature; Leak Survey
Stable Threats	Manufacturing TRA4, 21	• Long seam defects/SSWC • Pipe defects • Pressure cycling • Girth weld defects	Supplier Approval; Pipe Specification; Fitting Specification; Product Inspection; Design Standards; Post Construction Pressure Test; ILI *; Assessment Pressure Test
	Construction/ Fabrication TRA3, 30, 37	• Couplings/pressure welds • Wrinkle bends • Saddle type connection • External loading	Construction Practices; Inspection during construction; ILI; Vintage Pipe Replacement Program
	Equipment TRA15, 25, 26	• Equipment age / obsolescence • Incorrect sizing / design • Deferred maintenance • Poorly manufactured equipment • Pipeline debris	Preventive maintenance; Inspection during maintenance
Time Independent Threats	1st, 2nd, & 3rd Party Mechanical Damage TRA6, 14, 19, 23, 39	• Vandalism • Terrorism • Shallow cover • Ineffective public awareness	Public Awareness & Damage Prevention; Cyber Security; Patrolling / Continuing Surveillance; Locate and Mark; ILI; Shallow Pipe Program; Pipeline Markers
	Incorrect Operations TRA11, 22, 35, 36, 37, 38	• Incorrect procedure • Human error	Operating Procedures; SCADA / Network Visibility; OQ / Training and Development; Audits
	Weather & Outside Forces TRA10, 12, 20, 28, 32	• Water crossings • Unstable soil/erosion • Heavy rains/floods • Seismic activity • Subsidence • Landslide (includes soil creep)	Patrolling/ Continuing Surveillance; Fault Crossing Program; Vintage Pipe Replacement Program (ARDF + Construction); Geotechnical Hazard Monitoring Program; CPSI; Levee & Water Crossing Program; IL
Reliability	Failure to Meet Customer Demand	• Inadequate capacity	Hydraulic Models for all Transmission Systems; Long Term Investment Planning
Emergency Response	Major Emergency or Disaster	• Inadequate/Incorrect EOC response • Inadequate/Incorrect first responder response • Inadequate/Incorrect gas control response • Inadequate/Incorrect dispatch response • Inadequate/Incorrect training	Online Pipeline Simulation Rupture Detection; Valve Automation; Transmission Control Center; Business Continuity Plans; Gas Emergency Response Plan (GERP); SCADA Outage Manual Operations Plan; Company Emergency Plan; GERP-Based Exercises

availability and the quality of the asset data

complete | partial | weak

= Mitigation for Interacting Threat

TRA# - Risk Register Name

Mitigation Color Key

Green = Meets or exceeds industry best practices AND controls are adequate

Amber = Partially meets industry best practices OR controls are being strengthened

Red = Does not meet industry best practices AND current controls are not adequate

White = Pending Evaluation *Not yet implemented

Threat Matrix (Distribution Mains and Services)

Approved: 10/12/2018

		Primary Causes of Failures	Primary Prevention Measures (highest impact on risk reduction - from left to right)				
Time Dependent Threats	External Corrosion DMS15;DMS17;DMS12;DMS3	Inadequate coating Inadequate Cathodic protection Atmospheric conditions	Cathodic Protection	Leak Survey	Asset Replacement		
	Internal Corrosion DMS4	Sulfur Water intrusion	Leak Survey	Leak Repair	Asset Replacement		
	Material or Weld – Plastic DMS5;DMS22;DMS6	Poor resin quality Rock impingement/ stress on pipe	Material Specifications	Inspection during Manufacturing	Leak Survey	Asset Replacement	
Stable Threats	Material or Weld – Metallic Pipe DMS23;DMS7;DMS12	Poor quality manufacture Inadequate specifications	Material Specifications	Inspection during Manufacturing	Leak Survey	Asset Replacement	Process Safety
	Equipment Related DMS25	Age, Obsolescence Incorrect sizing/design	Preventive maintenance	Work Procedures	Training	Asset Replacement	
Time Independent Threats	Excavation Damage DMS8;DMS1;DMS39;DMS2	1st, 2nd, 3rd Party Excavation Damage Inadequate Procedures	Quality Management	Locating and Marking	One Call System	Public Awareness	
	Incorrect Operations DMS10;DMS11	Human Error Cross Bores Applicant Installed Fusion Joints	Procedures	Process Safety	Training	Operator Qualifications	Quality Management Inspecting during const.
	Natural Forces DMS7;DMS14	Lightning; Flooding Seismic events; Land movement	Design	Relief	Emergency Preparedness Procedures	Asset Replacement	
	Other DMS38;DMS37	Vandalism Vehicular damage Overbuilds	Design	Physical Barrier to Asset	Asset Relocation or Replacement		
Loss of Supply	Failure to meet customer demand	Inadequate Capacity Improper Clearances	Long term Investment Planning	Clearance Process and Tools			
Emergency Response	Major Emergency or Disaster	Inadequate First Responder Response Inadequate Dispatch response Inadequate EOC Response Inadequate training	Odor Response	Shut-in Time	Emergency Response	Emergency Shutdown Zones	

availability and the quality of the asset data

complete | partial | weak

Mitigation Color Key

Green = [illegible]

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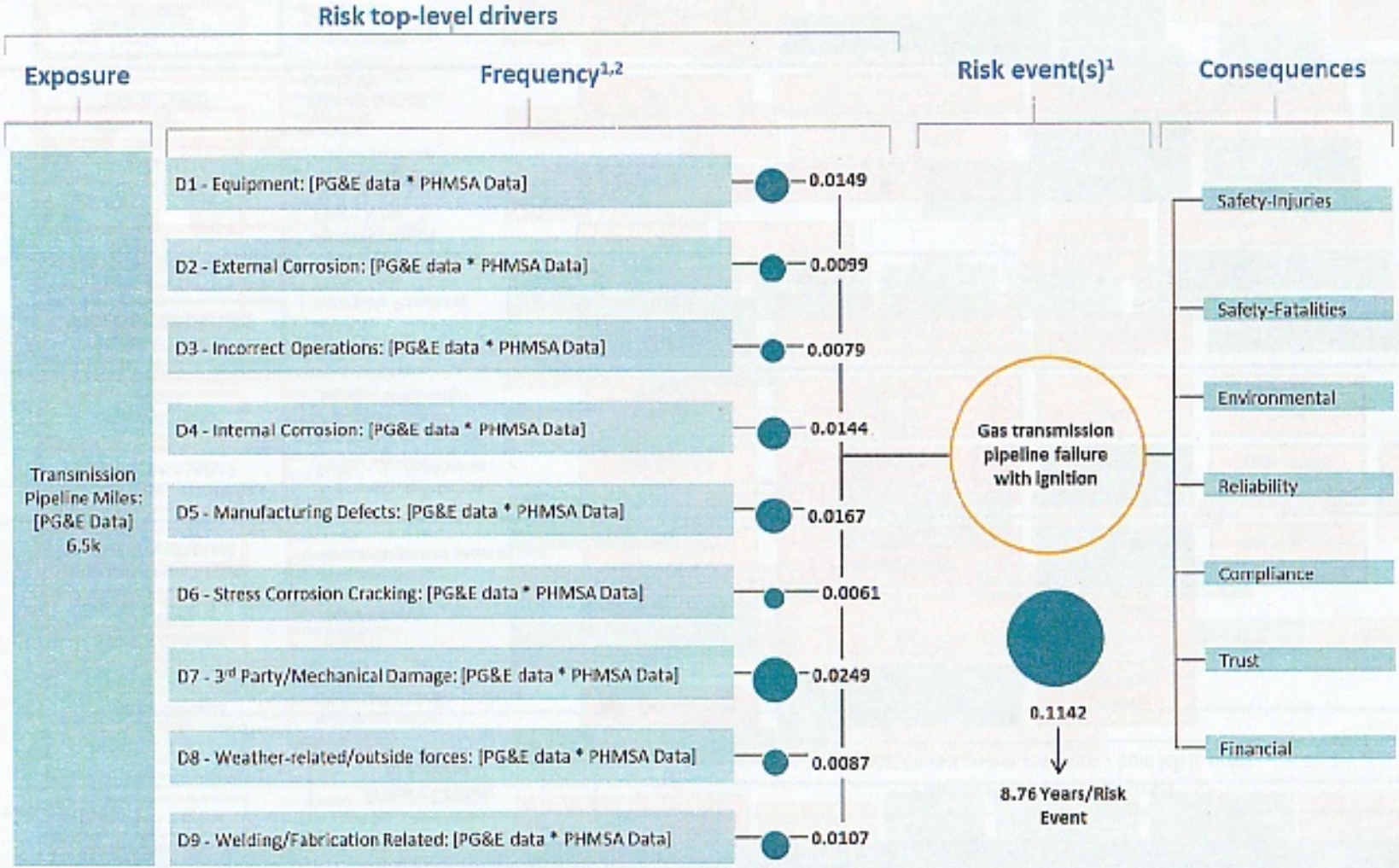
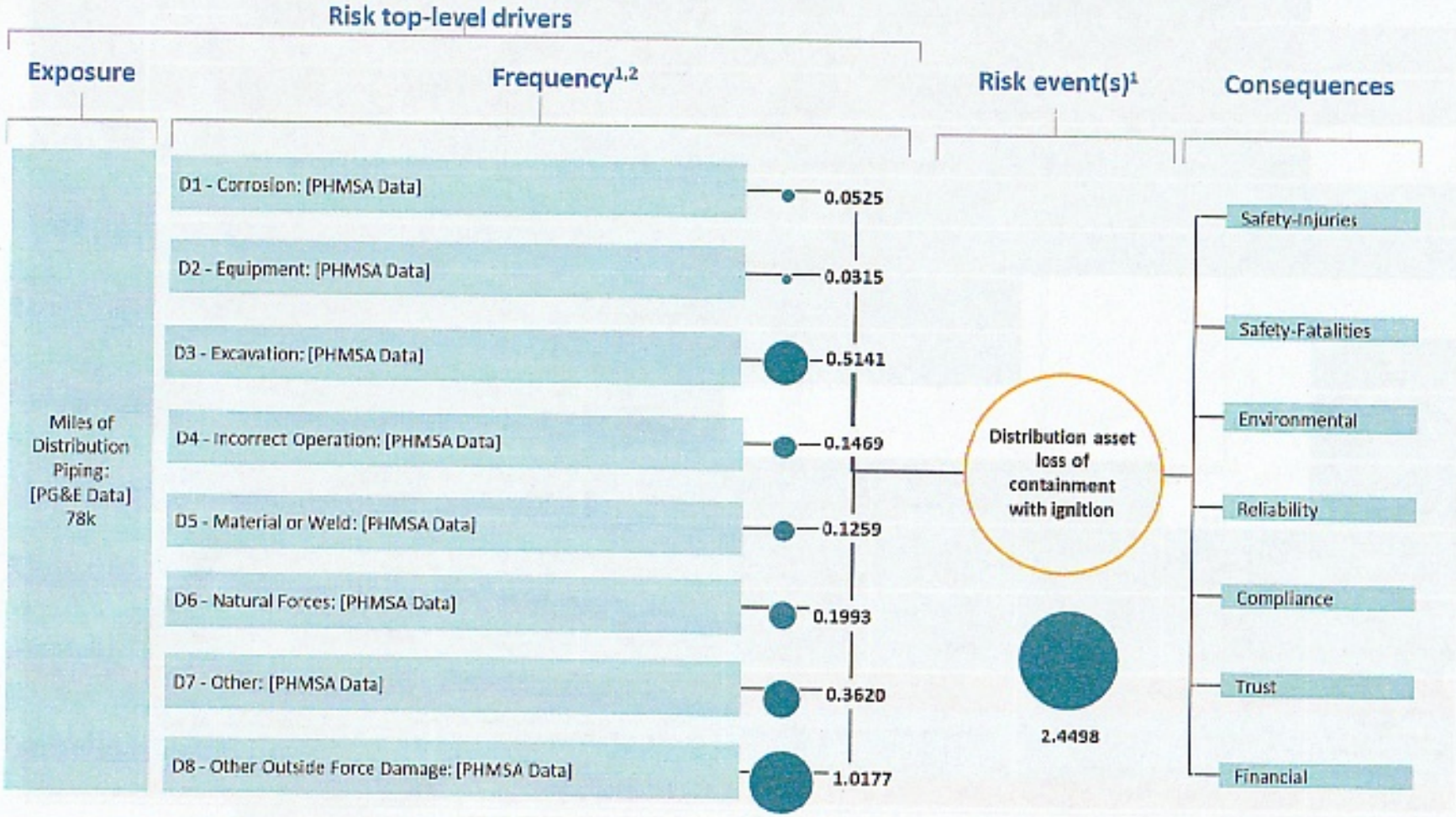
Transmission Pipe



[1]Values displayed are means of each distribution and are in the units of events/year. Driver frequencies are summed to obtain the Risk event frequency.
[2]Drivers are modeled using Poisson and Binomial distributions.

Release of Gas with Ignition on Distribution Facilities – Non-Cross Bore



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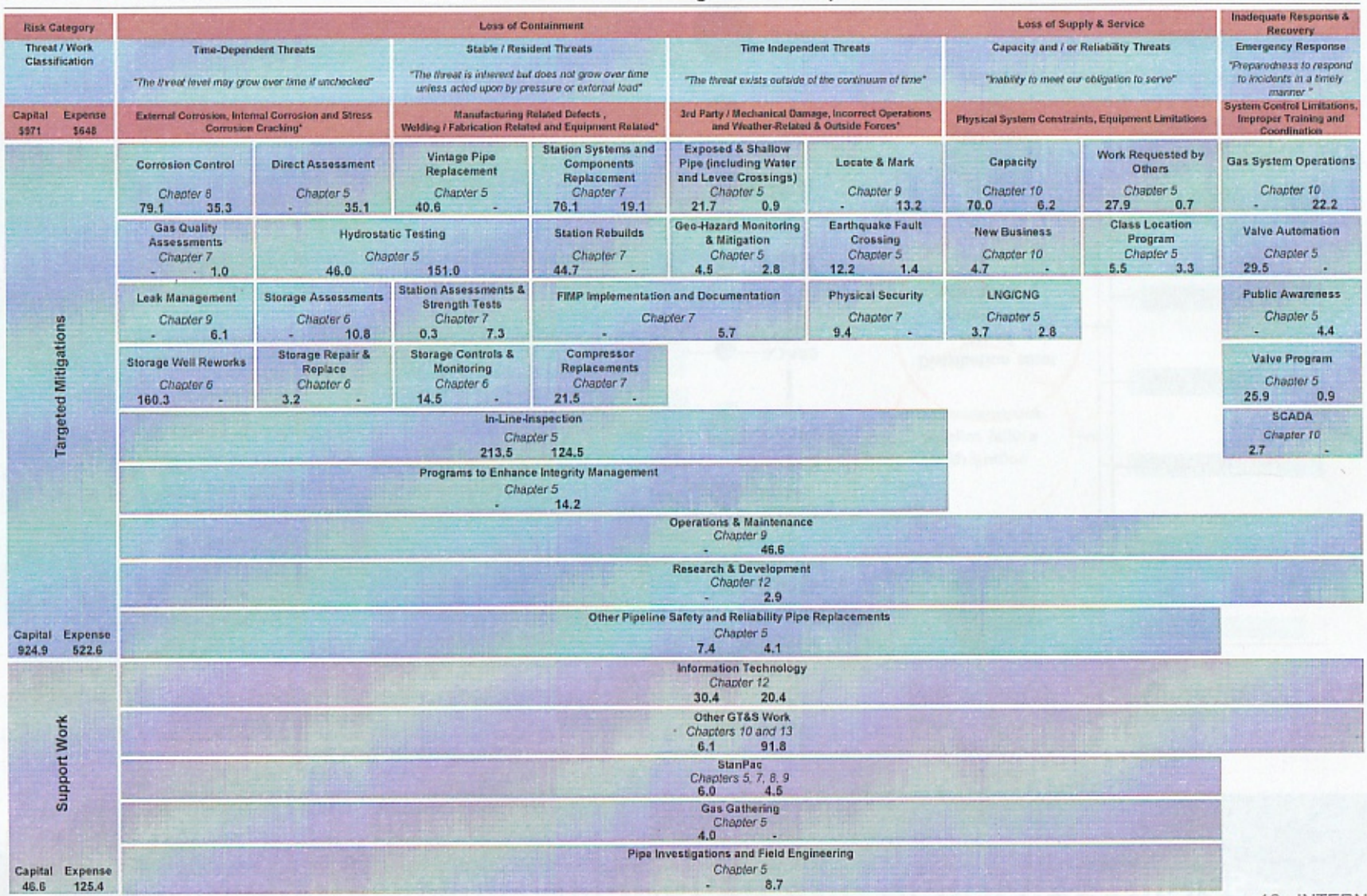
2019 GT&S Risk Placemat

2019 GT&S Rate Case - Risk Mitigation Summary "Placemat"



2020 GRC Risk Placemat

Risk Category	LOSS OF CONTAINMENT			LOSS OF SUPPLY & SERVICE	INADEQUATE RESPONSE AND RECOVERY
Risk Driver Classification	TIME DEPENDENT	STABLE	TIME INDEPENDENT	CAPACITY AND/OR RELIABILITY	EMERGENCY RESPONSE
Targeted Controls & Mitigations	**Aldyl-A Main Replacement** Expense $ - Capital $ 258.5 *CHAPTER 4*	**Distribution Station Updates** Expense $ - Capital $ 113.2 *CHAPTER 5*	**Cross Bore Program** Expense $ 29.9 Capital $ - *CHAPTER 4*	**Distribution System Capacity** Expense $ - Capital $ 39.4 *CHAPTER 9*	**Emergency Shut Down Zone Valves** Expense $ - Capital $ 13.6 *CHAPTER 4*
		LNG / CNG Upgrades & Maintenance Expense $ 3.8 Capital $ 4.1 *CHAPTER 5*	**Locate and Mark** Expense $ 41.1 Capital $ - *CHAPTER 6*		
	Corrosion Control Expense $ 27.5 Capital $ 18.6 *CHAPTER 7*	**Station Overpressure Protection Enhancement** Expense $ - Capital $ 13.8 *CHAPTER 5*			
		SCADA Expense $ - Capital $ 29.2 *CHAPTER 9*			
	Reliability Main Replacement Program Expense $ - *CHAPTER 4* Capital $ 46.8			**Work Requested by Others** Expense $ 6.0 Capital $ 162.6 *CHAPTER 10*	**Emergency Response** Expense $ - Capital $ 0.9 *CHAPTER 8*
	GPRP Main Replacement Expense $ - *CHAPTER 4* Capital $ 124.7				
	Distribution Integrity Management Program Expense $ 11.7 *CHAPTER 4* Capital $ -				
	Leak Survey & Repair Expense $ 66.6 *CHAPTER 8* Capital $ 38.3				
	Operations & Maintenance Expense $ 46.6 *CHAPTER 6* Capital $ -				
	Field Services Expense $ 45.5 *CHAPTER 6* Capital $ 2.0				
	Gas System Operations Expense $ 15.2 *CHAPTER 9* Capital $ -				
Expense $ 293.7 Capital $ 934.4	**Other Construction** Expense $ - *CHAPTER 4* Capital $ 68.8				
Support Work Expense $ 78.4 Capital $ 15.2	**Technology and Other Distribution Support** Expense $ 78.4 *CHAPTER 11* Capital $ 15.2				

Risk Factors and Parameters Considered for Trees in the Lafayette area (207 total)

- The predominant risk factors in PG&E's risk model is 1) the horizontal proximity the tree is to the pipeline, and 2) the depth of cover above the pipeline.
- Contributing risk parameters that are all important and increase the risk profile of the pipeline are as follows:

Pipeline Threats	**Weather Related and Outside Forces** – Landslides, erosion, wind, flooding, lightning are factors to consider where tree roots affect buried pipelines. When a tree is uprooted or is in close proximity to the pipeline, large tree roots entangled around a pipeline can potentially pull on, or even extract a pipeline from the ground. Lightning strikes often involve trees, and can provide the mechanism for increasing the susceptibility of lightning damage to the buried pipeline. Lightning can strike a tree and propagate through the roots to the soil surrounding a pipeline.
	Corrosion - Buried pipelines rely upon external coating and cathodic protection (CP), to protect the pipe and mitigate external corrosion. Tree roots can damage external protective coatings by creating coating holidays (coating voids or gaps), growing against the pipe, and penetrating between the coating and the pipe surface. Depending upon the tree root system and/or coating systems, disbonded (but still intact) coating can also prevent CP from adequately protecting the pipe surface in a phenomenon known as CP shielding. Shielding can be exacerbated by the presence of tree root entanglements surrounding the pipe surface. Therefore, tree roots can negatively affect two barriers used to protect the external pipe surface – external coatings and cathodic protection.
	Excavation Damage - Independent studies have identified that one of the most significant factors contributing to the threat of someone inadvertently striking and damaging a pipeline (referred to as 3rd Party Damage and includes anyone knowingly or unknowingly performing an excavation along the ROW) is the ability of the public to identify and recognize a pipeline ROW. Heavy vegetation within the ROW prevents corridor recognition and contributes to the potential for inadvertent impact of a pipeline by a 3rd party excavator.
Damage Prevention	Impact on ability to perform routine maintenance and monitoring
	Reduction of recognizable ROW
	Reduction in damage prevention capabilities
Emergency Response	Increased time frame required in emergency response and pipeline integrity investigations

Risk Factors and Parameters Considered for Trees in Lafayette (207 total), cont.

- Weather Related and Outside Force and Excavation threats are a significant risk contributor to the pipeline since these threats are more difficult to manage since they are a time independent threat which is cannot be as easily monitored or predicted as other time dependent threats like corrosion.

- **Supporting Evidence:** The development of PG&E's risk model was informed by industry recommended practices (PIPA – Pipelines and Informed Planning Alliance), benchmarking against other utilities in the industry and independent research from a tree root study where locations were excavated and data collected to inform the risk parameters of the model.

Planned Project Information

Planned Transmission Pipeline Projects in Lafayette (as of April 2019)			
Line	**Approximate Location of Pipeline Project**	**Footage of Pipeline and Number of Valves**	**Planned Date of Execution**
L-191B	McGraw Lane to Meadowlark Court	In-Line Inspection ~1,200 feet	2019
DFM 3001-01	St. Marys Road between South Lucille Lane and Rohrer Drive and 2nd Street and Golden Gate Way	Replace ~450 feet	2019
DREG5203	Near Intersection of Olympic Oaks Drive and Olympic Boulevard	1 valve	2019
L-191-1	Olympic Boulevard and Reliez Valley Road	Replace ~600 feet 1 automated valve 11 manual valves	2019 - 2020
L-191-1	Near Intersection of Reliez Station Road and Olympic Blvd	ILI Receiver ~83 feet 1 valve	2019 - 2020
L-191-1	Near Intersection of Olympic Oaks Drive and Olympic Boulevard	Replace ~50 feet	2021
L-191-1	Near Intersection of Moraga Boulevard and 3rd Street	Replace ~1,100 feet	2021