Appendix 6G
Equations and Codes Used in Model

Table 6G-1. Equations Used in the Model

Index	Risk Variable	Equation	Lowest Risk	Highest Risk
Risk Total	**IndexSum**	(ThdPtySum + DesignSum + CorrSum + IncOpsSum) * (1 - [leaks_unknown]/10)	400	0
	Risk	IndexSum / LIF	1000+	0
Third Party	**ThdPtySum**	([depth_cover] + [activity] + [exposed_facilities]+ [one_call] + [patrol] + [public_edn] + [ROW_cond]) * (if([leak]=1,0.9,if([leak]=5,0.9,1)))*[repair_thd_pty]	100	0
	depth_cover	[cover]*4	20	0
	activity	1/([utilities] + [one_calls] + [pop]+0.5)*15 + [activity_WPC]/2	20	0
	exposed_facilities	[abv_grnd_WPC]/2 + if([cover]=1,0,5)	10	0
	one_call	[one_call_score]	15	0
	public_edn	[public_ed]	15	0
	ROW_cond	[ROW]	5	0
	patrol	([grnd_patrl_freq] * [grnd_patrl_eff]) + ([air_patrl_freq] * if([ROW]<3,0.5,[air_patrl_eff]))	15	0
Corrosion	**CorrSum**	([atmos_corr] + [buried_environ] + [internal_corr] + [cath_prot] + [coating_buried] + [interference] + [mech_corr] + [ILI]) * (if([leak]=2,0.9,if([leak]=7,0.9,if([leak]=5,0.9,1)))) *[ILI_corr_flaw]*[repair_corr] *(if([yr]<94,0.8,1))	100	0
	atmos_corr	if([atm_facilities]>0,([atm_corr]+[atm_coating]),10)	10	0
	buried_environ	if([casings]>0,0,[soil_corr])	10	0
	internal_corr	([prod_corr]+if([drain]=1,0,5))*(if([yr]<94,.5,1))	20	0
	cath_prot	([CIS] + [test_lead])/2*[ILI_corr_flaw]	15	0
	coating_buried	([CIS]/2+[test_lead]/2+[coat_type]*[coat_age])*(if([coat_insp]>0,if([coat_insp]>5,1,0.8),0.2)) *([ILI_corr_flaw])	15	0
	age		0	0
	interference	if([yr]>=98,5,1)+if(([utilities]+[casings])=0,8,if(([utilities]+[casings])<5,3,0))	15	0
	mech_corr	([soil_corr] + [pipe_stress_fatigue])/3	5	0
	ILI	if([yr]>=98,10,[ILI_age]*[ILI_tech])	10	0
	CIS	[CIS_reading]*if([yr]>=98,1,[CIS_age])	*10*	
	atm_corr	if([casings]>0,0,[atm_type])	*5*	*0*
	test_lead		*10*	*0*
	coat_insp	if([yr]>=98,12,[89coat_inspect]+[90coat_inspect]+[91coat_inspect]+[92coat_inspect]+[93coat_inspect]+[94coat_inspect]+[95coat_inspect]+[96coat_inspect]+[97coat_inspect]+[98coat_inspect])	*20*	
	casings	[casing_shorted] + [casing_unchecked] + [casing_clear]	*count*	*0*
	atm_facilities	if([casings]>0,1,0)+[shallow_cover]+if([abv_grnd_WPC]<10,1,0)+if([coat_type]=1,1,0)		
Design	**DesignSum**	([pipe_fctr] + [sys_fctr] + [fatigue] + [surge] + [integrity_test] + [earth_mvmnts]) * (if([leak]=3,0.9,if([leak]=8,0.9,if([leak]=5,0.9,1))))*[repair_design]	100	0
	pipe_fctr	if([pipe_maxpress]/[MOP]<1,0,if(([pipe_maxpress] / [MOP])>2,20,([pipe_maxpress] / [MOP]-1)*20)*ILI_design_flaw)	20	0
	sys_fctr	if(max_press]/[MOP]<1,0,if([max_press] / [MOP] >2, 10,([max_press]/[MOP]-1)*10)*ILI_design_flaw)	10	0
	fatigue	[pump_dist_72] + if([yr]>=94,5,[integrity_test]/4)+ [pipe_stress_fatigue]	15	0

Table 6G-1. (Continued)

Index	Risk Variable	Equation	Lowest Risk	Highest Risk
	surge	[surge_score] + [pipe_stress_surge]	15	0
	integrity_test	if([hydro_test]+[crack_ILI]>20,20,[hydro_test]+[crack_ILI])	20	0
	earth_mvmnts	[scour] + [seismic] + [landslide_potential]	20	0
	hydro_test	if([hydro_ratio] * [hydro_age]<0,0,([hydro_ratio]*[hydro_age]))	*20*	
	crack_ILI	[crack_ILI_age] * [crack_ILI_type]	*20*	
	max_press	if([pipe_maxpress]< [other_maxpress], [pipe_maxpress], [other_maxpress])		
Incorrect Ops	**IncOpsSum**	([construction_design] + [training] + [procedures] + [maps_records] + [overpress_pot] + [safety_sys] + [maint] + [communications] + [mech_err_prev] + [risk_ass]) * (if([leak]=4,0.9,if([leak]=5,0.9,1)))	100	0
	construction_design	[construction_design_score]	10	0
	training	[training_score]	20	0
	procedures	[procedures_score]	15	0
	maps_records	[maps_records_score]	5	0
	overpress_pot	([surge_score]*5/7.5)+[pipe_stress_fatigue]+[ov_press_pot]/3	10	0
	safety_sys	[safety_sys_score]	10	0
	maint	[maint_score]	10	0
	communications	[communications_score]	10	0
	mech_err_prev	[mech_err_prev_score]	5	0
	risk_ass	[risk_ass_score]	5	0
Data	activity_WPC air_patrl_eff		15 1	
	air_patrl_freq		15	
	atm_coating		5	
	atm_coating		5	
	atm_type		5	
	casings			
	CIS_age	if(year(NOW()) - ([CIS_date]) >5,0,(1-(year(NOW())-([CIS_date]))/5))		
	CIS_reading	if([yr]>=98,10,[CIS_98])	10	
	coat_age	if(99-[yr]<5,1,if(99-[yr]<10,0.8,if(99-[yr]<20,0.6,if(99-[yr]<50,0.4,0.2))))		
	coat_type		5	
	crack_ILI_age	if(year(NOW()) - year([crack_ILI_date]) >5,0,(1-(year(NOW())-year([crack_ILI_date]))/5))	#	
	crack_ILI_date			
	crack_ILI_type		20	
	cover		20	
	drain_volume	3000/[drain]		

Table 6G-1. (Continued)

Index	Risk Variable	Equation	Lowest Risk	Highest Risk
Data	flow_volume	[flowrate]/24*0.25		
	grnd_patrl_eff		1	
	grnd_patrl_freq		15	
	hydro_age	if(year(NOW()) - year([hydro_date]) >5,0,(1-(year(NOW())-year([hydro_date]))/5))	#	
	hydro_date			
	hydro_press		#	
	hydro_ratio	if([hydro_press]/[MOP] > 1.5,0.5,([hydro_press]/[MOP]-1))*40	20	
	ILI_95		10	
	ILI_age	if(year(NOW()) - year([ILI_date]) >5,0,(1-(year(NOW())-year([ILI_date]))/5))		
	ILI_corr_flaw	if([ILI_flaw] = 7, 0.9,if([ILI_flaw]=0,if([yr]>=98,1.0,0.9),1))		
	ILI_design_flaw	if([ILI_flaw] = 8,0.9,if([ILI_flaw]=9,0.9,if([ILI_flaw]=0,0.9,1)))		
	ILI_flaw	if([ILI_95] = 10,if([yr]>=98,10,(1-([ILI_age])/10)),[ILI_95])	10	
	ILI_tech		10	
	joint_fctr			
	landslide_potential		6.6667	
	leak_detect_volume	[leak_detect_rate]*[leak_detect_time]*[flowrate]/24		
	MOP			
	MOP%_gas_72		10	
	one_call_score		15	
	one_calls		5	
	other_maxpress			
	pipe design factor			
	pipe_Barlow1	[pipe_barlow]		
	pipe_maxpress	[pipe_barlow] * (if([yr]<72, (if([pipe_seam] = 1, (if([integrity_test] < 5, 0.8, 0.95)), 0.95)),0.95))		
	pipe_NOP			
	pipe_seam			
	pipe_stress_fatigue	[MOP%_gas_72]/2	5	
	pipe_stress_surge	[MOP%_gas_72]*.75	7.5	
	pipe_toughness			
	pop_activ		5	
	public_ed		15	
	pump_dist_72		5	0
	repair_corr	if([repair_ind] = 2, 0.9,if([repair_ind]=5,0.9,if(repair_ind=6,0.9,1)))		
	repair_design	if([repair_ind] = 3, 0.9,if([repair_ind]=5,0.9,if(repair_ind=6,0.9,1)))		
	repair_multiple			
	repair_thd_pty	if([repair_ind] = 1, 0.9,if([repair_ind]=5,0.9,if(repair_ind=6,0.9,1)))		
	repair_unknown			
	scour		6.6667	
	seismic	if((5-[seismic_PGA]/4)<0,0,(5-/[seismic_PGA]/4))	5	0
	shallow_cover	if([cover]=0,1,0)		
	surge_score		7.5	