

# API RBI User Group

AST Module V8

February 22, 2006

Lynne C. Kaley

The Equity Engineering Group, Inc.

Houston, TX USA



# AST Overview

- Module divided into two components, Course and Floor
- Course POF and DF calculated like pressure vessel
- Floor POF and DF calculated based on adjusted corrosion rate and floor POF model
- Consequence of failure for course and floor reported in Financial terms
  - Environmental Clean-up Costs & Penalties
    - + Function of volume released and environmental sensitivity
  - Repair Costs
  - Lost Opportunity Costs
- Not reflected on 5x5 Risk Matrix for area based risk
- Financial Matrix coming in V8

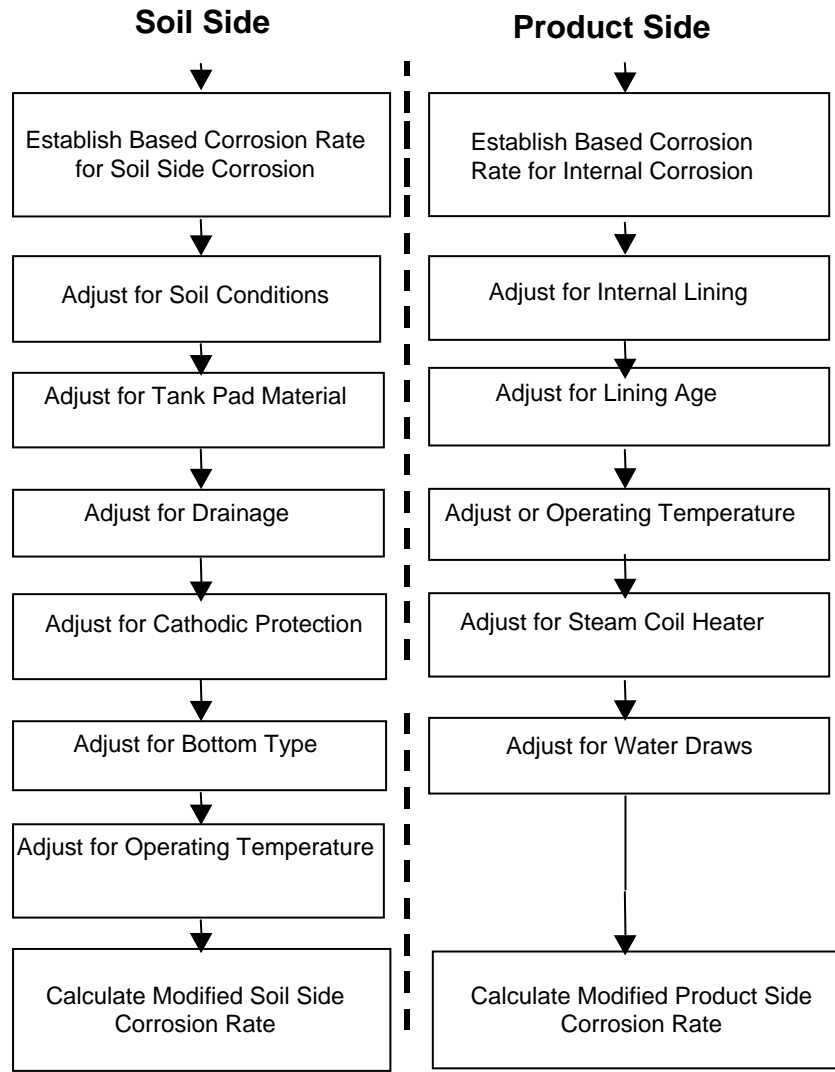
# AST – Course POF

- Model up to 10 Courses
- Fill height, Course height input required
- Damage Types and Mechanisms same as fixed equipment
  - Defaults apply so no POF is calculated unless user inputs rates/susceptibilities
- $T_{\min}$  computed based on API 650 considering hydrostatic head

# AST – Floor POF

- POF model developed specifically for tank floor
- Based on work with API tank committee
- $T_{\min}$  computed based on API 650 minimum required thickness for a tank floor
  - RPB - 0.05"
  - No RPB - 0.10"
- All relevant DF Modules are available including the Lining Module
- Modified ar/t table developed for industry experience
- Corrosion Rate Supplements developed for the product side and soil side corrosion
- Only 0 or 1 inspection credit given

# AST – Floor POF

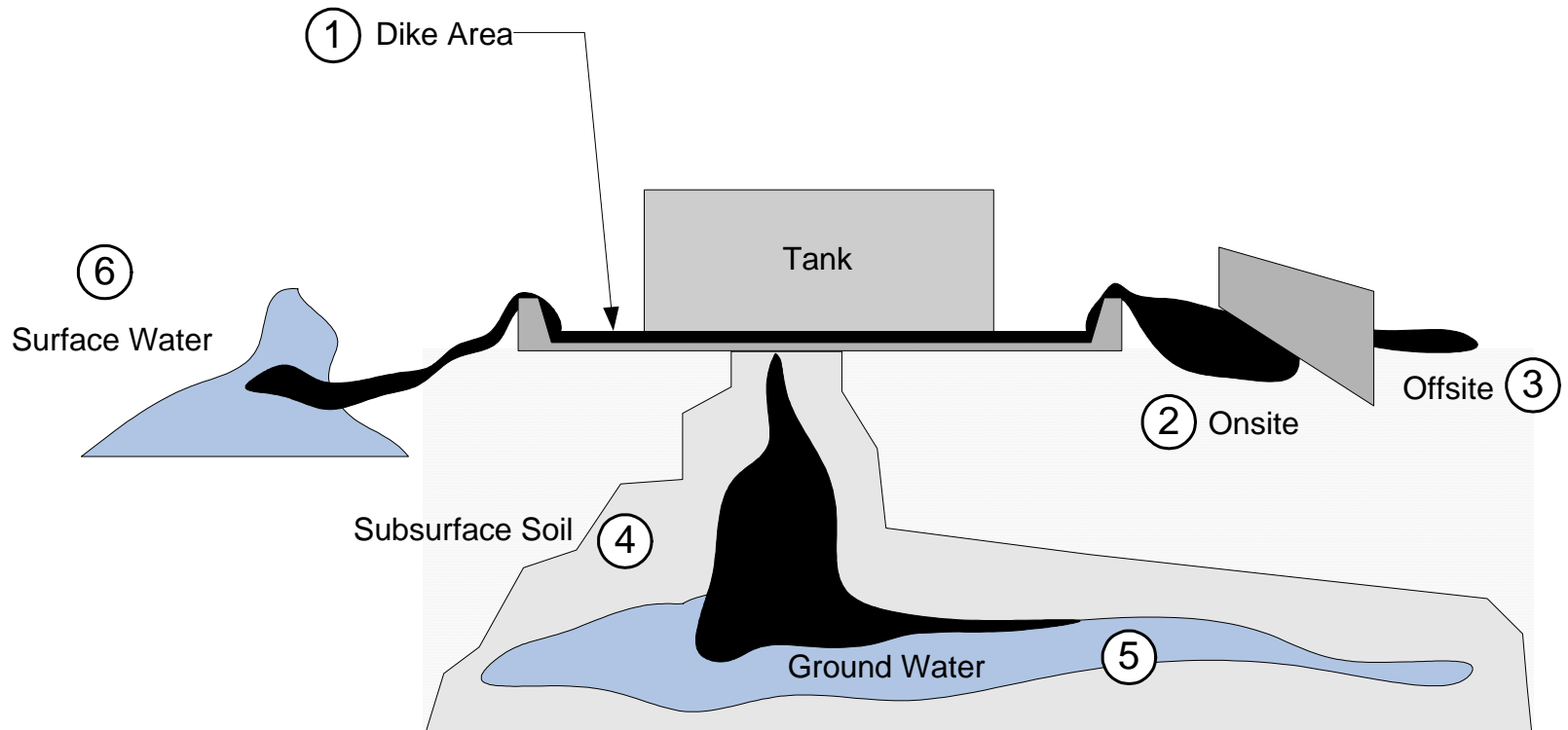


- Determine DF from modified ar/t table
- Localized Corrosion, largest corrosion rate
- General/Widespread corrosion, sum corrosion rates

# AST – Floor POF

	No Inspection	1 Inspection			
ar/t		Poorly	Fairly	Usually	Highly
0.05	4	1	1	1	1
0.1	14	3	1	1	1
0.15	32	8	2	1	1
0.2	56	18	6	2	1
0.25	87	32	11	4	3
0.3	125	53	21	9	6
0.35	170	80	36	16	12
0.4	222	115	57	29	21
0.45	281	158	86	47	36
0.5	347	211	124	73	58
0.55	420	273	173	109	89
0.6	500	346	234	158	133
0.65	587	430	309	222	192
0.7	681	527	401	305	270
0.75	782	635	510	409	370
0.8	890	757	638	538	498
0.85	1,005	893	789	696	658
0.9	1,126	1,044	963	888	856
0.95	1,255	1,209	1163	1,118	1,098
1	1,390	1,390	1,390	1,390	1,390

# AST COF



# AST COF

- Process fluid list limited – choices based on permeability through soil
- User to select best match fluid to viscosity
- Hole size data
  - Course – same as pressure vessel
  - Floor – industry based distribution
- No safety related consequence to course or floor failure
- Consequence in Financial terms based on:
  - Environmental Clean-up Costs & Penalties
    - + Function of volume released and environmental sensitivity
  - Repair Costs
  - Lost Opportunity Costs

# AST COF

<b>Fluid</b>	<b>Level 1 Consequence Analysis Representative Fluid</b>	<b>Molecular Weight</b>	<b>Liquid Density (lbm/ft<sup>3</sup>)</b>	<b>Liquid Dynamic Viscosity (lbf-s/ft<sup>2</sup>)</b>
Gasoline	C6-C8	100	42.702	8.383E-5
Light Diesel Oil	C9-C12	149	45.823	2.169E-5
Heavy Diesel Oil	C13-C16	205	47.728	5.129E-5
Fuel Oil	C17-C25	280	48.383	7.706E-4
Crude Oil	C17-C25	280	48.383	7.706E-4
Heavy Fuel Oil	C25+	422	56.187	9.600E-4
Heavy Crude Oil	C25+	422	56.187	9.600E-4

# AST COF

- Generic Failure Frequencies:

Equipment Type	Component Type	GFF as a Function of Hole Size				Total GFF
		Small	Medium	Large	Rupture	
Tank650	TANKBOTT OM	7.20E-04	0	0	2.00E-06	7.20E-04
Tank650	COURSE-1	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-2	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-3	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-4	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-5	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-6	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-7	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-8	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-9	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04
Tank650	COURSE-10	7.00E-05	2.50E-05	5.00E-06	1.00E-07	1.00E-04

*Note <sup>1</sup> - A Survey of API Members' Aboveground Storage Tank Facilities*

# AST Risk Determination

- Inspection Planning module is based on Financial Risk Target
- Total Cost (\$) =
  - Environmental Clean-up Costs + Environmental Penalties + Repair Costs + Lost Opportunity Costs
- Environmental Clean-Up Costs = Volume × CUF
  - Where Volume is in bbl
  - CUF (Clean-Up Factor), \$/bbl
    - + Accounts for complexity of cleanup and environmental sensitivity
- Final Risk using Consequence adjusted by POF

# AST Risk Determination

**Table 7.6 – Cost Parameters Based on Environmental Sensitivity**

Location (1)	Description	Environmental Sensitivity		
		Low	Medium	High
1	In Dike – Environmental cost for product located in the dike area	10	10	10
2	Onsite – Environmental cost for product located in surface soil located onsite	50	50	50
3	Offsite – Environmental cost for product located in surface soil located offsite	100	250	500
4	Water – Environmental cost for product in water	500	1,500	5,000
5	Subsoil – Environmental cost for product located in subsoil	500	1,500	3,000
6	Groundwater – Environmental cost for product located in groundwater	1,000	5,000	10,000

Note 1: See Figure 7.1

# Summary

- Key parameters for Consequence:
  - Environmental Sensitivity
  - Soil Type – driving permeability and contamination of groundwater
- Financial Risk Criteria
  - Target Risk must be assigned by user
  - Financial Risk target guidance difficult to provide
- Course risk is associated with on-site/off-site soil contamination and surface water contamination.
  - Dike containment used for course leaks
  - Controls financial impact
- Generally low risk for courses, floor risk driver for tank inspection