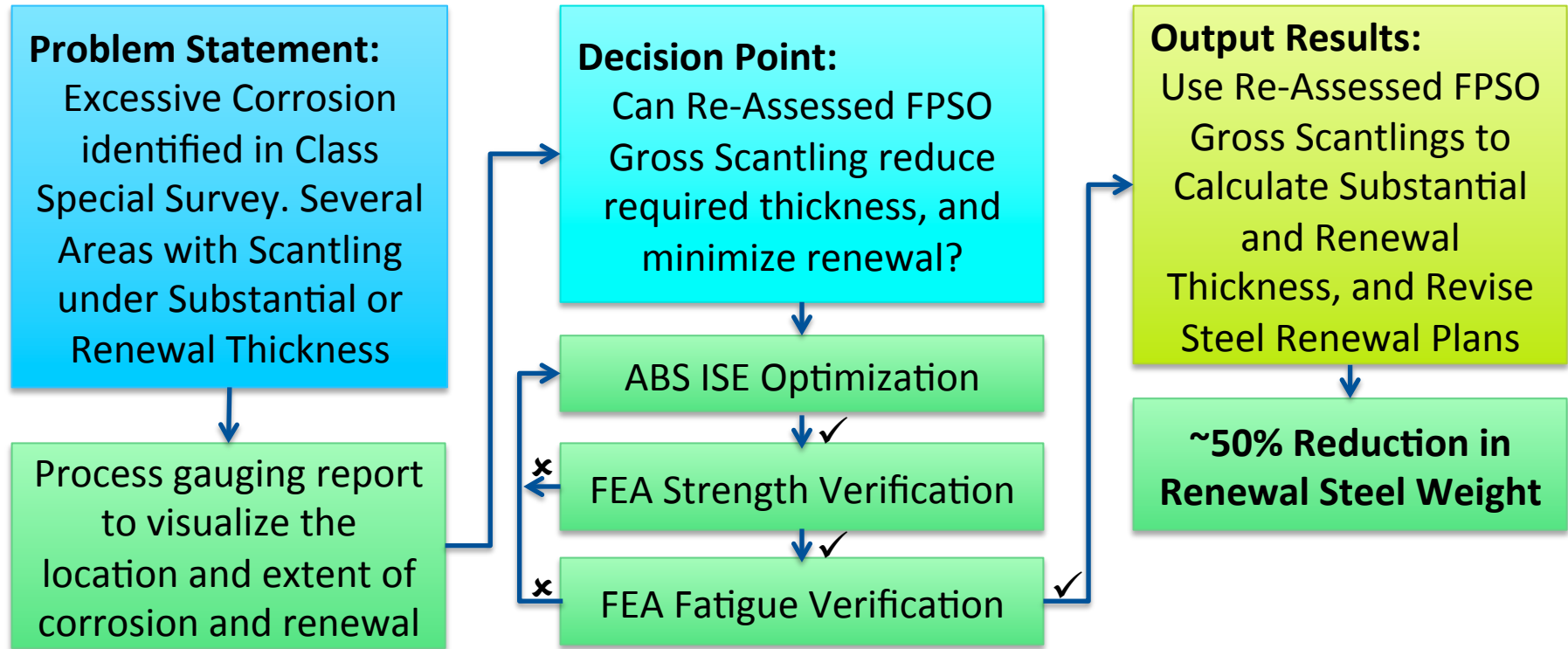


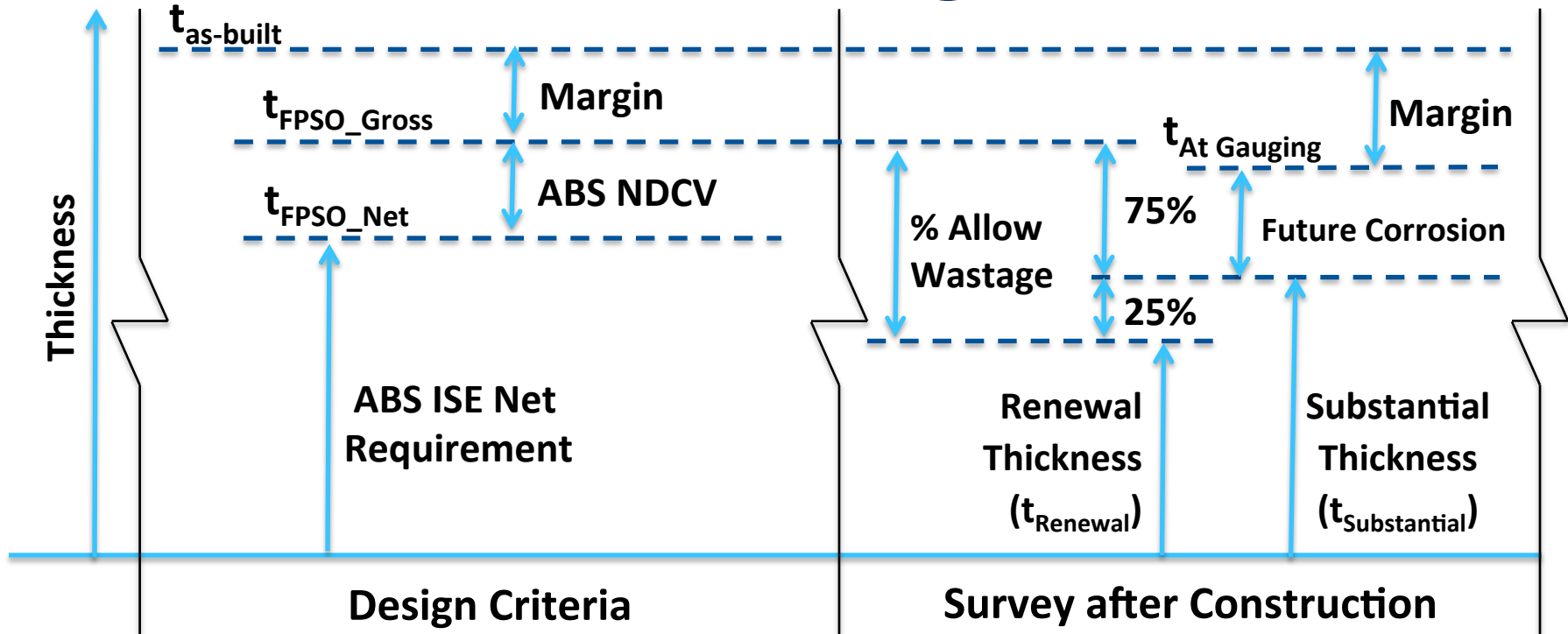
Structural Life Extension Study

FEA Based Corrosion Processing and
Structural Optimization to Minimize Steel
Renewal

Corrosion, Optimization , & Renewal



Reassessed Scantlings - Definitions



Step 1 - Corrosion Input and Processing

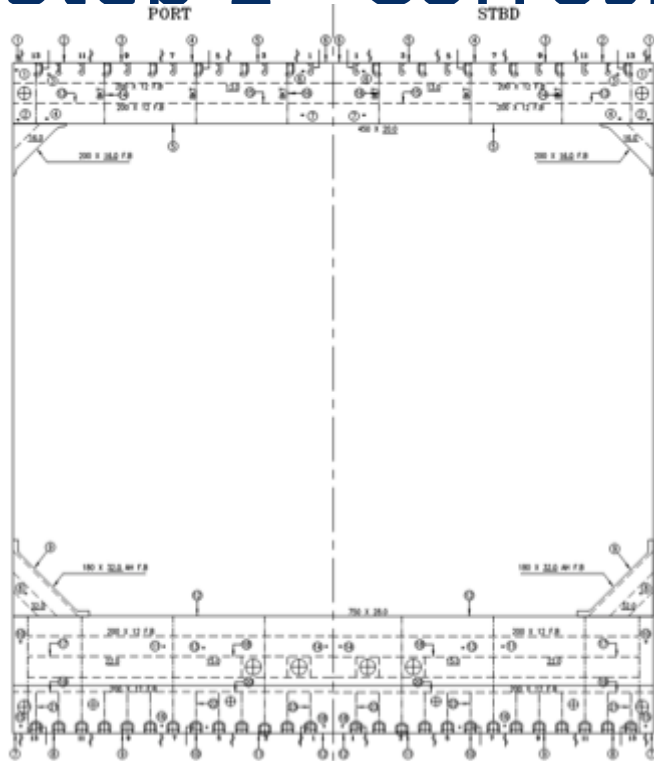


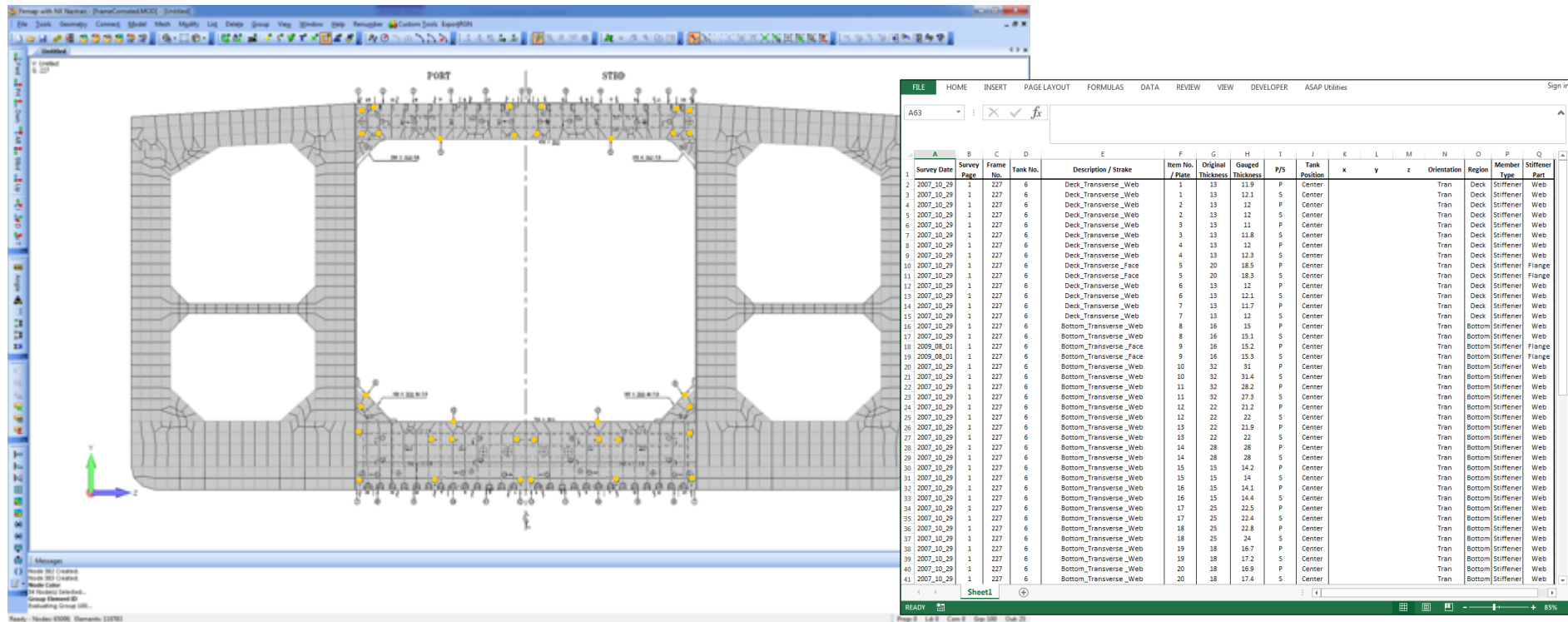
Plate Position		No. or Letter	Original Thickness (mm)	Present Thickness PORT	Present Thickness STBD	Diminution PORT (mm)	Diminution PORT %	Diminution STBD (mm)	Diminution STBD %	Maximum Allowable		Remarks
										Formula	mm	
Deck Transverse	Web	1	13.0	11.9	12.1	1.1	8.5	0.9	6.9	25%	3.3	
	Web	2	13.0	12.0	12.0	1.0	7.7	1.0	7.7	25%	3.3	
	Web	3	13.0	11.0	11.8	2.0	15.4	1.2	9.2	25%	3.3	
	Web	4	13.0	12.0	12.3	1.0	7.7	0.7	5.4	25%	3.3	
	Face	5	20.0	18.5	18.3	1.5	7.5	1.7	8.5	25%	5.0	
	Web	6	13.0	12.0	12.1	1.0	7.7	0.9	6.9	25%	3.3	
	Web	7	13.0	11.7	12.0	1.3	10.0	1.0	7.7	25%	3.3	
Bottom Transverse	Web	8	16.0	15.0	15.1	1.0	6.3	0.9	5.6	25%	4.0	
	Web	9	16.0	15.2	15.3	0.8	5.0	0.7	4.4	25%	4.0	
	Web	10	32.0	31.0	31.4	1.0	3.1	0.6	1.9	25%	8.0	
	Face	11	32.0	28.2	27.3	3.8	11.9	4.7	14.7	25%		
	Web	12	22.0	21.2	22.0	0.8	3.6	0.0	0.0	25%	5.5	
	Web	13	22.0	21.9	22.0	0.1	0.5	0.0	0.0	25%	5.5	
	Face	14	28.0	28.0	28.0	0.0	0.0	0.0	0.0	25%	7.0	
	Web	15	15.0	14.2	14.0	0.8	5.3	1.0	6.7	25%	3.8	
	Web	16	15.0	14.1	14.4	0.9	6.0	0.6	4.0	25%	3.8	
	Web	17	25.0	22.5	22.4	2.5	10.0	2.6	10.4	25%	6.3	
	Web	18	25.0	22.8	24.0	2.2	8.8	1.0	4.0	25%	6.3	
	Web	19	18.0	16.7	17.2	1.3	7.2	0.8	4.4	25%	4.5	
	Web	20	18.0	16.9	17.4	1.1	6.1	0.6	3.3	25%	4.5	
Adjacent Structure Member												
Deck Plate		1	23.5	22.0	22.2	1.5	6.4	1.3	5.5	20%	4.7	
Deck Plate		2	23.5	22.5	22.5	1.0	4.3	1.0	4.3	20%	4.7	
Deck Plate		3	23.5	22.7	23.0	0.8	3.4	0.5	2.1	20%	4.7	

Legend: Substantial corrosion

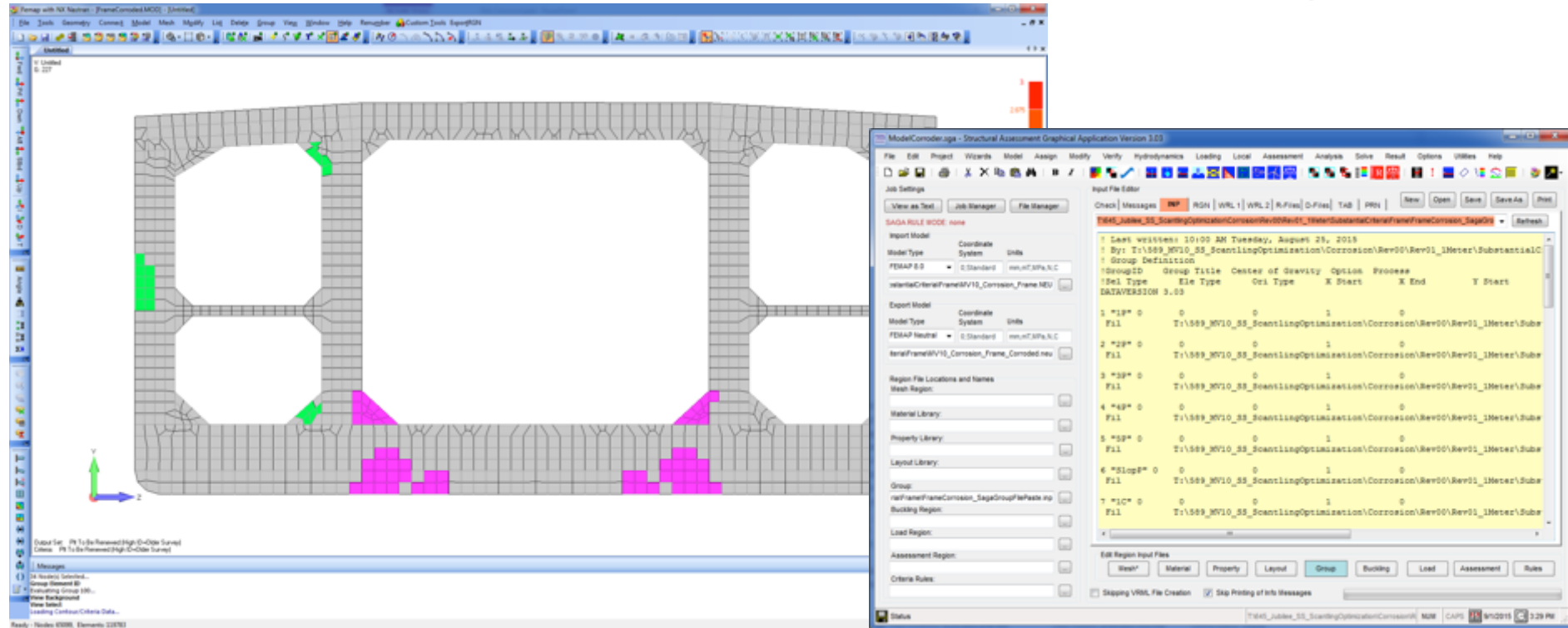
Renewal

Inspector:	M.Hafiz Zinal	Signed:		Date:	3rd December 2007
Client Rep:		Signed:		Date:	
Surveyor:	John A.B. Oyediji	Signed:		Date:	

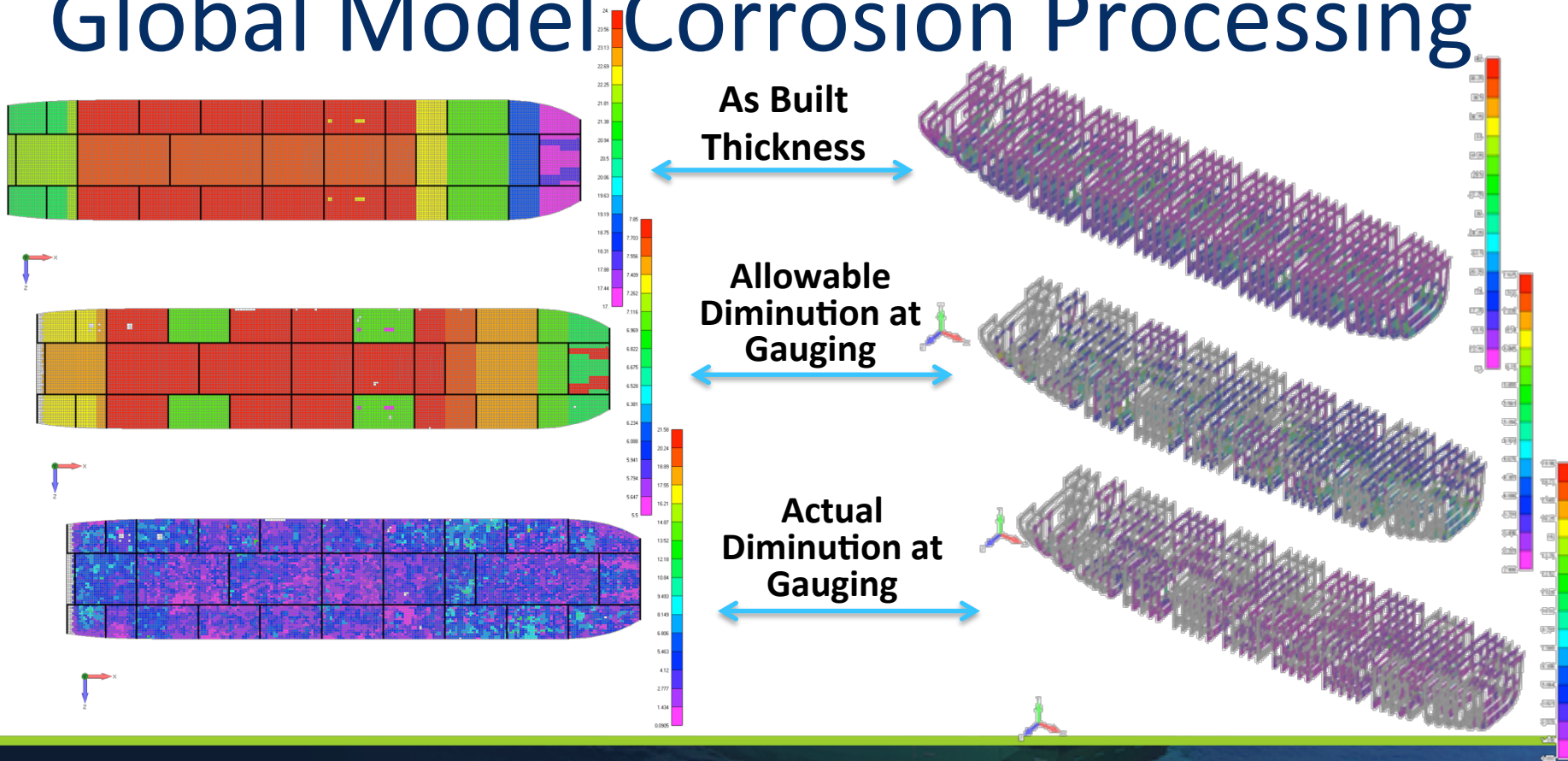
SAGA - FEA Model Based Corrosion Input



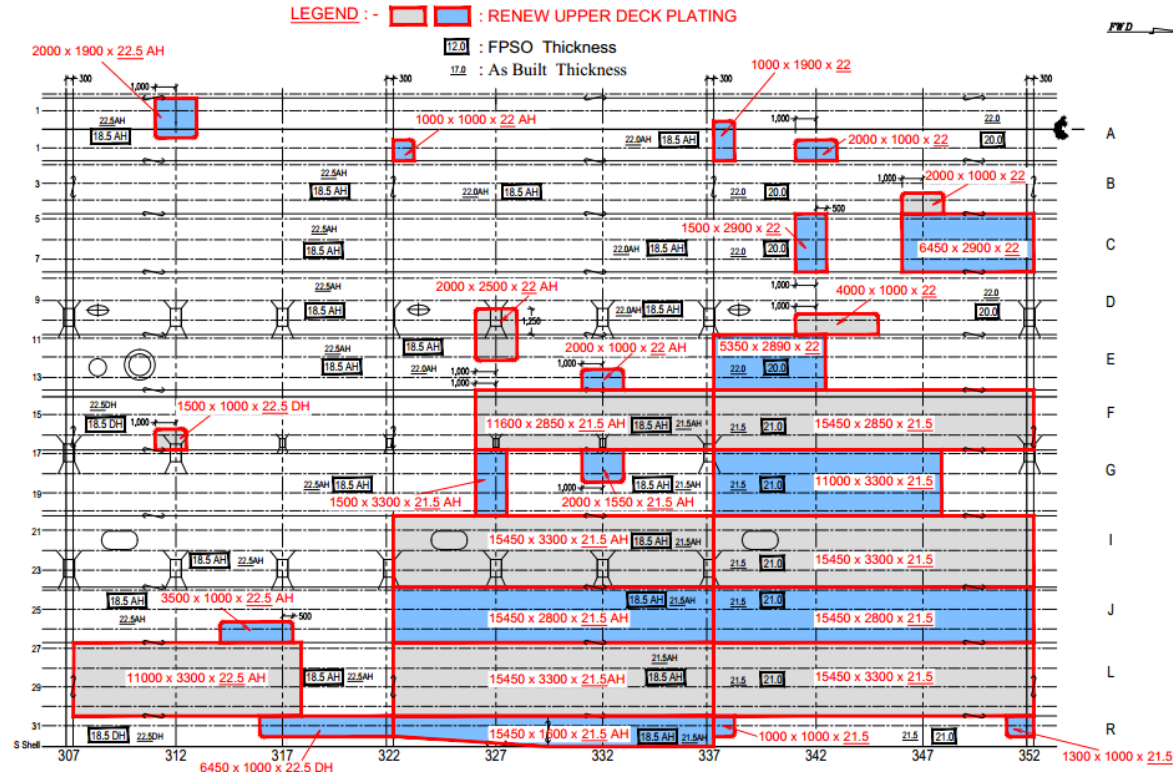
SAGA Corrosion Processing



Global Model Corrosion Processing



Steel Renewal Estimate – Main Deck

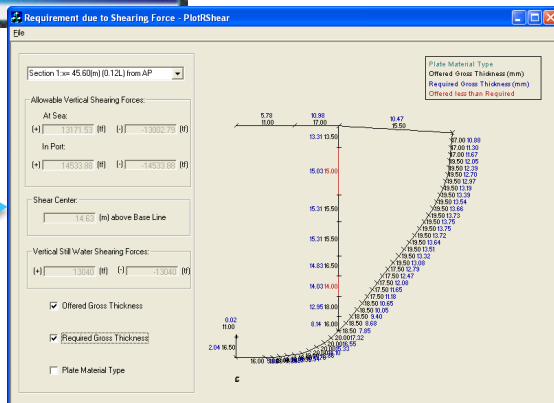


Scantling Reassessment - Optimization



ABS ISE
Software

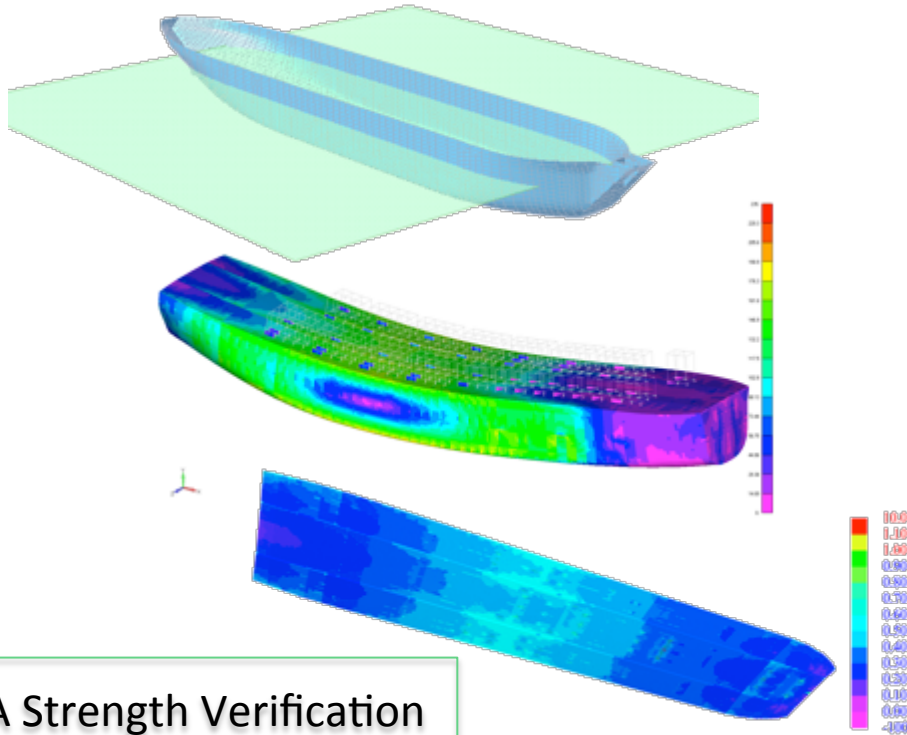
ABS HGSA
Software



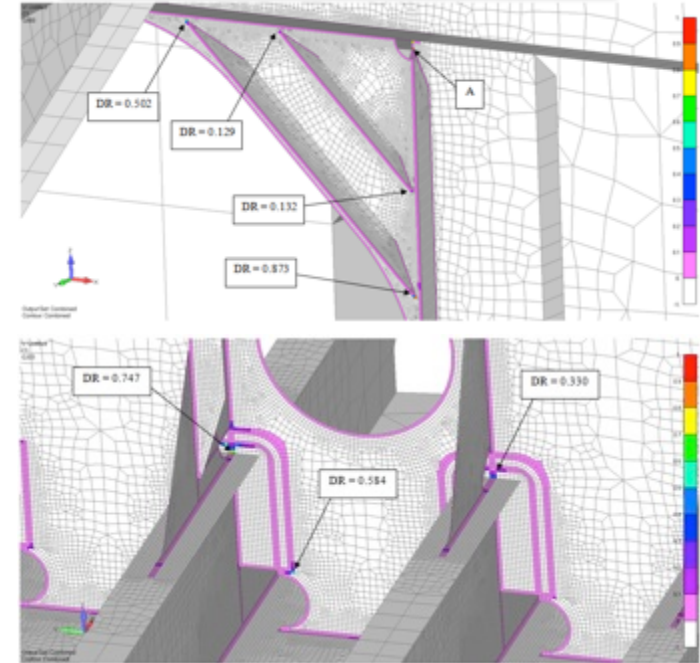
Upper Deck Plating in way of Cargo Tanks (mm)																	
Frame Location	Tank	Side	Plate ID	Material Type	Coating	Start of Strake Dist. ABL (m)	End of Strake Dist. ABL (m)	As-Built Thickness	ISE Input Thickness (FPSO)	Allowable Wastage Percent	FPSO Substantial Thickness	FPSO 10 yr. Anticipated Corrosion	10 yr. Renewal Thickness at Conversion	10 yr. Allowable Diminution at Conversion			
107-127	10	P/S	1	MILD	Non-Coated	L14	L31	20.50	15.5	20%	13.18	0.50	13.68	6.83			
127-142	9	P/S	1	HT36	Non-Coated	L14	L31	20.50	15.5	20%	13.18	0.50	13.68	6.83			
112-127	8	P/S	1	MILD	Non-Coated	CL	L14	21.00	16.0	20%	13.60	0.50	14.10	6.90			
127-142	8	P/S	1	HT36	Non-Coated	CL	L14	21.00	16.0	20%	13.60	0.50	14.10	6.90			
142-157	8	P/S	1	HT36	Non-Coated	L14	L31	22.00	17.0	20%	14.45	0.50	14.95	7.05			
157-172	8	P/S	1	HT36	Non-Coated	L14	L31	24.00	19.0	20%	16.15	0.50	16.65	7.35			
142-157	7	P/S	1	HT36	Non-Coated	CL	L14	22.00	17.0	20%	14.45	0.50	14.95	7.05			
157-172	7	P/S	1	HT36	Non-Coated	CL	L14	23.50	18.5	20%	15.73	0.50	16.23	7.28			
172-187	7	P/S	1	HT36	Non-Coated	CL	L14	23.50	18.5	20%	15.73	0.50	16.23	7.28			
187-202	6	P/S	1	HT36	Non-Coated	CL	L14	23.50	18.5	20%	15.73	0.50	16.23	7.28			
202-232	6	P/S	1	HT36	Non-Coated	CL	L14	23.50	18.5	20%	15.73	0.50	16.23	7.28			
	6	P/S	1	HT36	Non-Coated	L14	L31	24.00	19.0	20%	16.15	0.50	16.65	7.35			
232-262	5	P/S	1	HT36	Non-Coated	CL	L14	23.50	18.5	20%	15.73	0.50	16.23	7.28			
	5	P/S	1	HT36	Non-Coated	L14	L31	24.00	19.0	20%	16.15	0.50	16.65	7.35			
262-292	4	P/S	1	HT36	Non-Coated	CL	L14	23.50	18.5	20%	15.73	0.50	16.23	7.28			
292-307	3	P/S	1	HT36	Non-Coated	CL	L14	23.50	18.5	20%	15.73	0.50	16.23	7.28			
307-322	3	P/S	1	HT36	Non-Coated	L14	L31	22.50	17.5	20%	14.88	0.50	15.38	7.13			
307-322	2	P/S	1	HT36	Non-Coated	CL	L14	22.50	17.5	20%	14.88	0.50	15.38	7.13			
322-337	2	P/S	1	HT36	Non-Coated	CL	L14	21.50	16.5	20%	14.03	0.50	14.53	6.98			
322-337	2	P/S	1	HT36	Non-Coated	CL	L14	22.00	17.0	20%	14.45	0.50	14.95	7.05			
337-352	2	P/S	1	MILD	Non-Coated	CL	L14	22.00	17.0	20%	14.45	0.50	14.95	7.05			
352-367	2	P/S	1	MILD	Non-Coated	L14	L31	21.50	16.5	20%	14.03	0.50	14.53	6.98			
352-367	2	P/S	1	MILD	Non-Coated	CL	L14	19.00	14.0	20%	11.90	0.50	12.40	6.60			
352-367	1	P/S	1	MILD	Non-Coated	L14	L31	19.00	14.0	20%	11.90	0.50	12.40	6.60			
	1	P/S	1	MILD	Non-Coated	CL	L14	17.00	12.0	20%	10.20	0.50	10.70	6.30			
367-377	1	P/S	1	MILD	Non-Coated	L14	L31	17.00	12.0	20%	10.20	0.50	10.70	6.30			
377-387	1	P/S	1	MILD	Non-Coated	CL	L14	17.00	12.0	20%	10.20	0.50	10.70	6.30			
	1	P/S	1	MILD	Non-Coated	L14	L31	17.00	12.0	20%	10.20	0.50	10.70	6.30			

Steel Renewal Tables

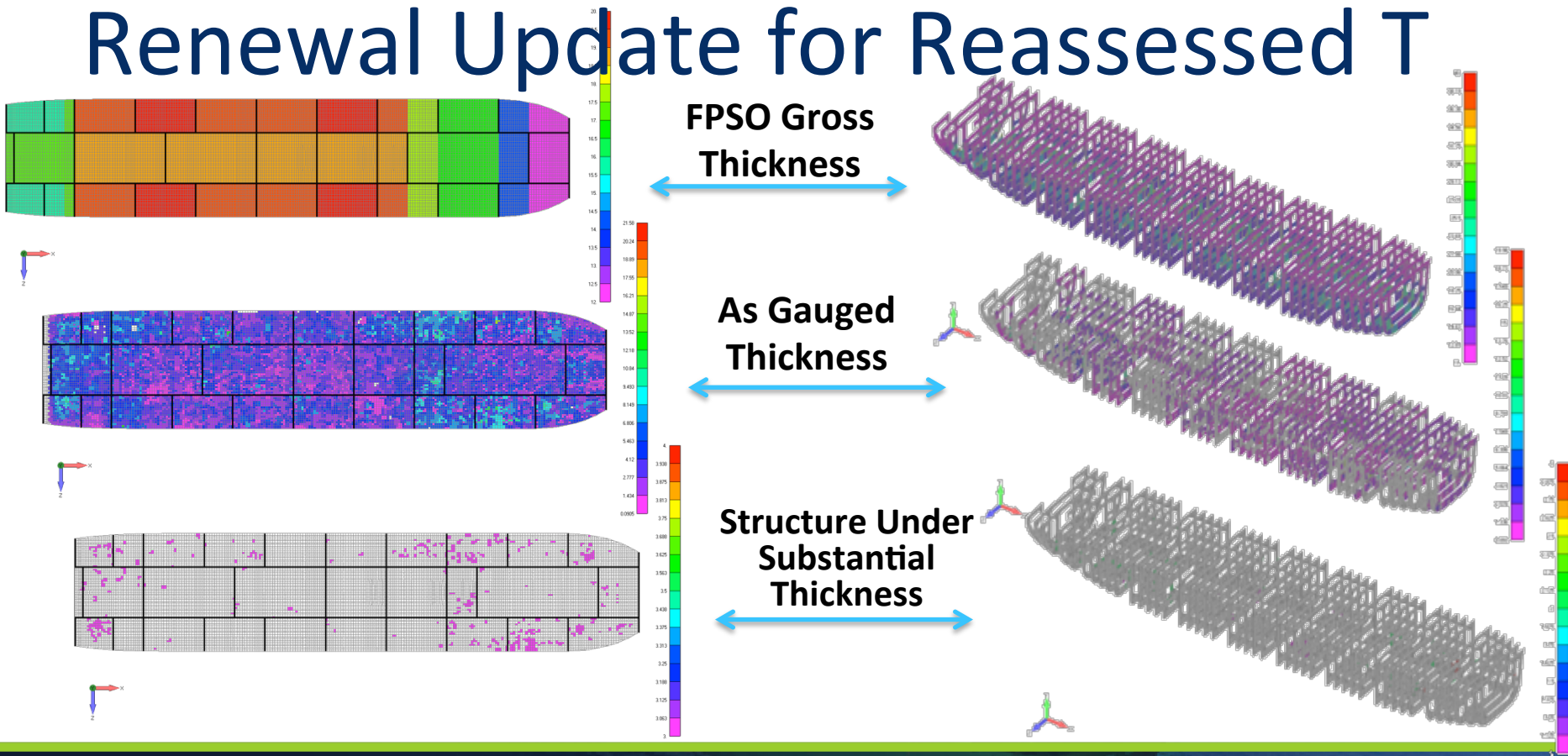
Reassessed Scantling Verification



FEA Fatigue Verification



Renewal Update for Reassessed T

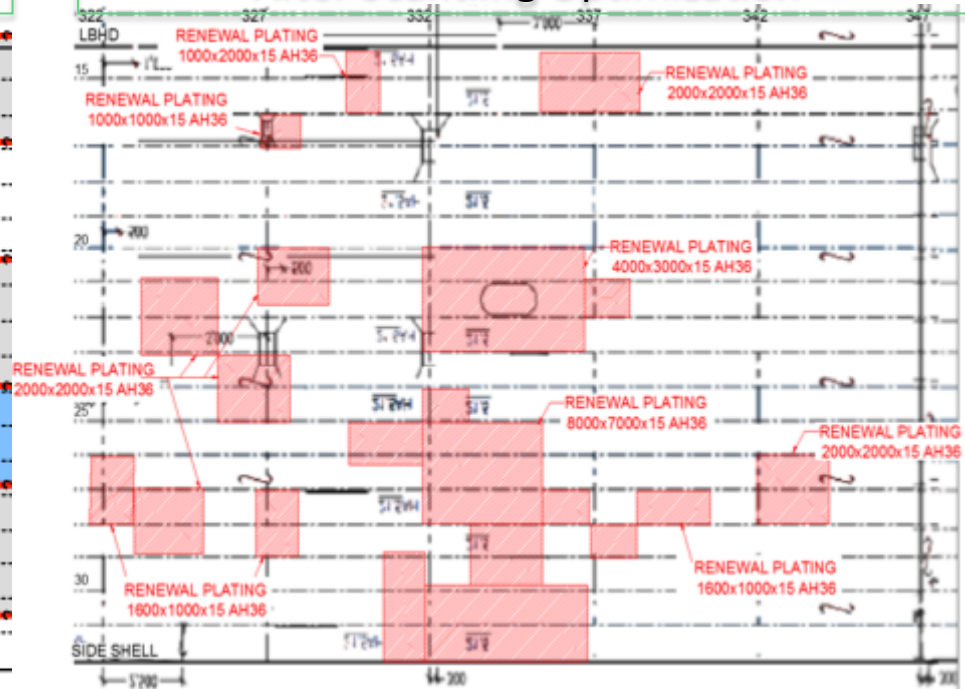


Steel Renewal Update – Tank 2S Main Deck

Before Scantling Optimization



After Scantling Optimization



Summary & Conclusions

- Numerous FSO / FPSOs are experiencing corrosion at a rate exceeding the expectations used at conversion
- Excessive corrosion threatens the feasibility and class approval of the hull structure
- Steel renewal options are limited, and expensive:
 - Steel renewal offshore - ~\$50,000 per mT of steel renewal
 - Leave operating site for ship repair yard
- Most Conversion FSO / FPSOs have some level of excessive strength margin
- Scantling Reassessment / Optimization can be an effective tool to reduce or eliminate steel renewal, but requires:
 - A proven method of processing the gauging data to identify the location and extent of excessive wastage
 - The experience to find the right balance between scantling reduction and hull strength / fatigue life