Source Reduction Evaluation 2008 2009 Part II

For Science Panel

ADEC 2010

Source Reduction Evaluation (SRE) Reporting

General:

- This part will discuss the SRE reporting results, items and ADEC's review findings.
- All items are Summarized (global) in Summary Document.
- Review of the SRE reporting was done by ADEC CPVEC staff.
- Presentation includes SRE Reporting by operator / vessels.

SRE Reporting 2008 2009 PCL

- General: Large Alaska Fleet 8-9 vessels (CCL)
  - Vessel overview (Table)

2008 2009 Season:	Vessel Name	Year Delivery	AWTS Type / Units Cap m3	2008 Discharge Status	2009 Discharge Status
	Coral	2002	Ham / 2x320		
	Diamond	2004	Ham / 3x320		
	Golden	2001	Ham / 3x320		
	Island	2003	Ham / 2x320		
	Pacific	1999	Ham / 2x150	Not visiting 2008	
	Sapphire	2004	Ham / 3x320		
	Sea	1998	Ham / 2x226	Not visiting 2008	
	Star	2002	Ham / 3x320		
	Sun	1995	Ham / 3x240		Not visiting 2009
	Dawn	1997	Ham / 3x240		Not visiting 2009
Notes: ND=Non Discharger D=Discharger HAM=Hamworthy – MBR AWTS					

Princess WW Sampling

Treatment System Type: Hamworthy

	Ammonia	Copper	Nickel	Zinc
Median	53	15.0	9.2	120.0
Average	57.9	25.3	13.9	131.7
Max	160	160	420	450
Min	0.1	0.25	2.92	18
95th Percentile	120	87.385	23.75	273.5
99th Percentile	145.6	134.35	68.9	404.8

- Note: Sample data does not include samples where there was a known malfunction in the treatment system. This was only two samples.

SRE Reporting 2008 2009

PCL [continued]

- I (a) Source Water Evaluation:
  - General discussions
  - Bunker water / Evaporator Water
  - Bunker water produced water Volumes Percentages (Table)
  - Evaporation systems identified
  - Identification Langlier Index potable water (corrosiveness)
  - Piping materials shore connections tanks not given for all vessels

PCL Water Sources

Vessel	Evaporator Water %	Bunkered Water %	Comments
Coral	72	28	
Diamond	53	47	
Golden	70	30	
Island	71	29	
Pacific	65	35	
Sapphire	53	47	
Sea	78	22	
Star	68	32	
Sun	Not visiting in 2009		
Dawn	Not visiting in 2009		

SRE Reporting 2008 2009

PCL [continued]

- Chemical use Evaporators (Vap treat)
- Carry over of metals in Evaporator from bio fouling system not identified.
- Tank coatings
- Source sampling performed (Table)
- Indentified soft water and causes (piping), including potential treatment (water balance).
- Strategic Bunkering OR findings

SRE Reporting 2008 2009

Vessel	Source	Location	Results* ug/L			Remarks
			Cu	Ni	Zn	
Star Princess						
[6/17/08]	Potable Water	Pot Water Tk (8&9)	15.3	1.74	17.8	
		Tap Bridge Pantry 14	19.5	1.87	26.9	
		Cabin 10 FWD (hot)	52.3	8.27	33.5	
		Cabin 8 FWD STB (hot)	56.3	8.2	34.9	
		Cabin Deck 11 Mid ship	44.7	2.21	33.7	
		Cabin Deck 4 Port	41.6	1.85	40.0	
		Tap Crew Galley 5 Aft (hot)	26.3	10.4	25.2	
[6/18/08]	Treated WW	Des. OB Dis Sample Port	59.2	13.6	123	
	WW	Alt. OB Dis Sample Port	116	258	183	
	BW influent	Influent MBR BW Evac 4	17	8.58	115	
	GW influent	Influent MBR GW buffer Tk	22.5	7.64	94.6	
	Potable Water	Pot Water Tk (11&12)	17.6	1.48	18	
[6/20/08]	Evaporator 1		49.7	3.13	15.4	
	Evaporator 3		42.5	1.04	51.8	
[6/23/08]	Evaporator 2		50.3	1	28.1	
[6/25/08]	Treated WW	Des. OB Dis Sample Port	55.5	15.7	119	
Golden Princess						
[6/7/09]	Evaporators		49	2.3	60	

^The sample flow from the Evaporators combined, separate samples per evaporator are not made.

SRE Reporting 2008 2009

PCL [continued]

- I (b) Chemical Use / Process Evaluation
  - Identification cleaning products
  - Use of Hepburn Bio products in toilet care etc.
  - Review Hotel procedures
  - Chemical substitutions made (leaching potential)
  - Drain pipe cleaners (anti scaling chemicals) usage not identified.

SRE Reporting 2008 2009

PCL [continued]

- I (c) Water Supply Evaluation
  - ACA study
  - PCL performed bunker water sampling
  - Summary Table Selected sample results (See ACA results Table)

II Treatment Technology Evaluation / Implementation

- Princess Fleet has only Hamworthy AWTS systems installed
- GW from galleys and laundry is generally not treated and is stored in holding tanks.

SRE Reporting 2008 2009

PCL [continued]

- Ammonia is a "structural" problem for PCL Hamworthy systems.
- Bio Care product are used to create better pre-treatment of the organic waste stream (pipe system)
- Ammo 100 product usage to convert ammonia to nitrate (dosage in the aeration chamber)
- Nutrient dosage, foam fighters in EVAC tanks were used
- Golden Princess selected to do Pilot project
  - "Ammonia Removal Trail" (SRE Report Exhibit 4, April 14 2009)
  - MBR 3 changes (1st stage) conversion Anoxic Tank, 2nd stage will serve as an aerobic tank. TK 5 used as mixing tank. (nitrification improvement)
  - Control system installed (Tank 5, Ammonia meter, dosage, level)
  - Waste water characterization: Laundry water and Sanitary GW have low levels ammonia.

SRE Reporting 2008 2009 PCL [continued]

- GW effectively dilutes BW ammonia loading

In 2009 was reported that Phase 1 was completed

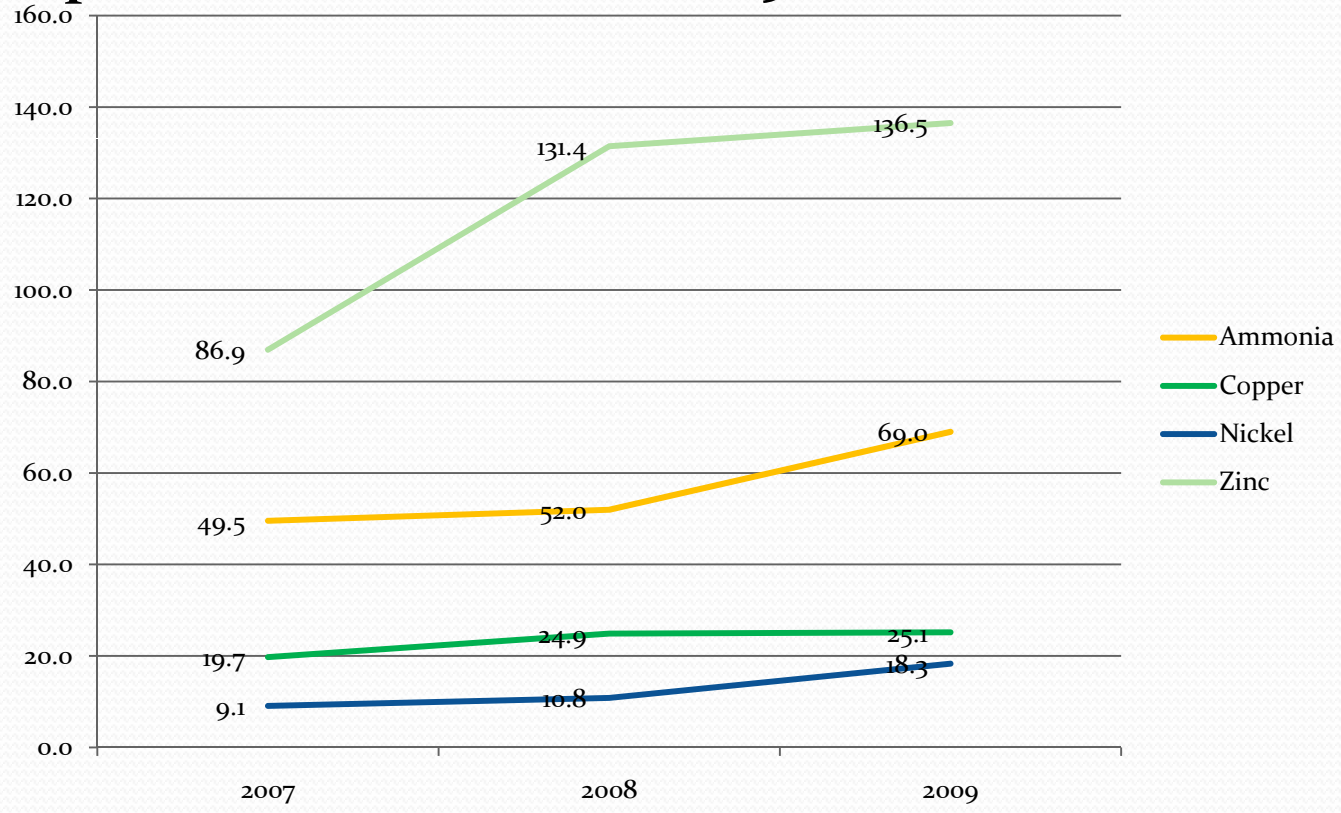
- Nitrification was not further improved by lower capacity
- Higher DO

Suggestions from Hamworthy:

- Dedicate one MBR unit for BW
- Increase BW GW ratio (1:3)
- BW GW ratio was not clearly identified earlier was 1:2 identified.
- Hamworthy on other vessel (Seven Seas Mariner)

SRE Reporting 2008 2009 PCL [continued]

Sample Result Trends 2008 2009



SRE Reporting 2008 2009 HAL

- General: Large Alaska Fleet 8 vessels (CCL)
  - Vessel overview (Table)

2008 2009 Season:	Vessel Name	Year Delivery	AWTS Type	2008 Discharge Status	2009 Discharge Status
	Oosterdam Westerdam Zuiderdam (Vista Class)	Oosterdam 2003 Westerdam 2005 Zuiderdam 2002	Rochem	Oosterdam ND Westerdam BW only No visit 2008 season	No Visit 2009 season Westerdam ND Zuiderdam ND
	Ryndam Statendam Veendam (S Class)	Ryndam 1994 Statendam 1993 Veendam 1996	Zenon	Ryndam D Statendam D Veendam D	Ryndam D Statendam D Veendam ND
	Volendam Zaandam Amsterdam (R Class)	Volendam 1999 Zaandam 2000 Amsterdam 2000	Zenon N/A	Volendam D Zaandam D Amsterdam ND	Volendam ND+ Zaandam D Amsterdam ND
Notes: ND=Non Discharger D=Discharger +=Discharged 2009 May Only					

HAL Zenon WW Sampling

Treatment System Type: Zenon

	Ammonia	Copper	Nickel	Zinc
Median	13.0	6.08	12.40	60.00
Average	16.3	8.2	14.7	61.7
Max	57	52	133	196
Min	0.051	0.25	3.6	0.5
95th Percentile	38.3	21.975	22.08	140
99th Percentile	50.65	49.928	40.476	188.2

Westerdam WW Results

Vessel	Treatment System	Sample Date	mg/L Ammonia	ug/L Copper	ug/L Nickel	ug/L Zinc	S.U. pH	col. per 100 ml Fecal Coliform	mg/L TSS	mg/L BOD	mg/L Chlorine
Westerdam	Rochem	5/14/2008	36	ND	5.97	124	7.42	0	0	20.9	0
Westerdam	Rochem	5/28/2008	130	6.47	4.69	47.2	7.56	2	0	47.9	0
Westerdam	Rochem	6/4/2008	100	1	3.8	23	7.58	2	0	13.2	0
Westerdam	Rochem	6/11/2008	130	4.45	8.85	501	7.7	2	0	16.5	0
Westerdam	Rochem	7/16/2008	69	1.31	5.29	36.5	7.2	0	0	41.3	0
Westerdam	Rochem	8/6/2008	57	ND	4.21	39.5	7.48	2	0	4.3	0
Westerdam	Rochem	8/7/2008	67	2.6	6.3	62	7.45	0	1	2.8	0
Westerdam	Rochem	8/13/2008	63	3.8	4.8	44	7.3	0	0	2.8	0
Westerdam	Rochem	9/3/2008	130	5.6	6.9	44	7.55	0	0	0	0
Westerdam	Rochem	9/17/2008	110	2.9	8.1	12	7.32	0	0	125.5	0

SRE Reporting 2008 2009 HAL [continued]

- I (a) Source Water Evaluation:
  - General discussions per Vessel Class (R /V / S Class)
  - Bunker water / Evaporator water / RO
  - Bunker water produced water Volumes Percentages (Table)
  - Evaporation systems identified
  - Water pH treatment
  - Piping materials shore connections tanks

SRE Reporting 2008 2009 HAL [continued]

- 2008 Potable Water Sources:

Vessel	Produced Water Volume %		2008 Season Bunkered Water Volume % Port							Vessel Class
	E water	T water	SEA	VAN	KTN	JNU	SKG	HNS	SWD	
Oosterdam	78	-	5	-	11	7	-	-	-	V-Class
Westerdam	81	-	-	-	12	7	-	-	-	V-Class
Ryndam	34	13	-	15	19	6	13	-	-	S-Class
Statendam	52	-	-	24	14	1	9	-	-	S-Class
Veendam	31	-	-	18	19	6	8	3	15	S-Class
Volendam	47	2	-	6	10	7	4	9	16	R-Class
Zaandam	41	-	-	4	13	9	5	10	17	R-Class

SRE Reporting 2008 2009

HAL [continued]

- 2009 Potable Water Sources

Vessel	Produced Water Volume %		2009 Season** Bunkered Water Volume % Port								Vessel Class
	E water	T water	SEA	VAN	KTN	JNU	SKG	HNS	SWD	VIC	
Amsterdam	ND		-								R-Class
Oosterdam	-		No visit in 2009 season								V-Class
Westerdam	ND		Sources not Reported no comparison possible								V-Class
Ryndam I	32	Note	-	10	18	25	6	-	9	-	S-Class
Ryndam II	25	Note	-	10	14	31	5	-	15	-	S-Class
Statendam I	55	Note!	-	10	7	20	-	4	-	4	S-Class
Statendam II	76	Note	-	7	4	7	4	2	-	-	S-Class
Veendam	-		Sources not Reported no comparison possible								S-Class
Volendam	-		Sources not Reported no comparison possible								R-Class
Zaandam I	59	Note	9	2	14	15	-	-	-	1	R-Class
Zaandam II	71	Note	3	-	16	10	-	-	-	-	R-Class
Zuiderdam	-		Sources not Reported no comparison possible								V-Class

**= Reported Graphs very hard to read / scaled percentage from graphs (approximate)
E water = Evaporator water made on board; T water = Technical water made on board.
SEA=Seattle (WA); VAN=Vancouver (BC); Alaskan Ports: KTN=Ketchikan; JNU=Juneau; SKG=Skagway; HNS=Haines; SWD=Seward.
ND=Non discharger
I=phase I May /June / July 2009. II=phase II August / September 2009
Note: Technical Water Volume % not specified /identified

SRE Reporting 2008 2009
HAL [continued]

- Chemical use Evaporators (Evap treat)
- Carry over of Copper in Evaporator (Cathelco system) bio fouling control system ? (ADEC question)
- Tank coatings
- Source sampling performed Evap / Laundry (Tables on next slide)
- Identified soft water and causes (piping).
- Strategic Bunkering Ocean Ranger findings

HAL 2008 Source Sampling

Vessel	Source	Location	Results* ug/L				Remarks
			NH3 mg/L	Cu	Ni	Zn	
Statendam	Evaporator^	Chlorination point	0.21	77	14	15	Zenon
8 25 08	Tech. water	Tech. water pump	0.25	320	15	64	
1993	Water Distr.	Potable stores	0	85	7.1	59	
	Galley GW	Galley drain tank	0.31	140	20	180	
	Laundry GW	Laundry drain tank	0.95	330	25	170	pH 10.57
	Acco. GW	AC room collection tk	1.3	240	27	360	
	Com. pre-treat WW	Buffer Feed tk bioreactor	69	150	20	270	Total Hardness 250
Zaandam	Evaporator	Chlorination point	0.1	140	120	60	Zenon
8 27 08	Tech. water	Tech. water pump	0.1	92	13	34	
2000	Water Distr.	Potable stores	0.057	160	17	76	
	Galley GW	Galley drain tank	0	98	11	13	
	Laundry GW	Laundry drain tank	0	2.2	18	13	pH 6.27
	Acco. GW	AC room collection tk	1	90.3	16	55	
	Com. pre-treat WW	Buffer Feed tk bioreactor	85	19	78	30	Total Hardness 68
Westerdam	Evaporator	Chlorination point	n/a	0.97	0.76	8.1	Rochem
8 28 08	Tech. water	Tech. water pump	0.17	570	6.8	190	
2005	Water Distr.	Potable stores	0	76	5.6	76	
	Galley GW	Galley drain tank	0.46	3.7	0.65	13	
	Laundry GW	Laundry drain tank	0.36	590	2.4	13	pH 9.0
	Acco. GW	AC room collection tk	4.8	110	22	55	
	Com. pre-treat WW	Buffer Feed tk bioreactor	150	19	17	30	Total Hardness 100

*Results obtained from Reported Graph / approximate.

^The sample flow from the Evaporators combined, separate samples per evaporator are not made.

SRE Reporting 2008 2009 HAL [continued]

- Statendam 2008 Sample Results

				Ammonia	Copper	Nickel	Zinc
Statendam	S-Class	Zenon	6/23/2008	13	ND	13	1.7
Statendam	S-Class	Zenon	6/30/2008	4.8	ND	6.01	3.1
Statendam	S-Class	Zenon	7/14/2008	24	ND	14.3	4.75
Statendam	S-Class	Zenon	7/28/2008	16	1.12	13.9	5.96
Statendam	S-Class	Zenon	8/11/2008	10	ND	17	2.2
Statendam	S-Class	Zenon	8/18/2008	11	1.5	15	5.3
Statendam	S-Class	Zenon	9/1/2008	27	3.2	14	7
Statendam	S-Class	Zenon	9/8/2008	10	2.6	17	4.8

SRE Reporting 2008 2009 HAL [continued]

- Zaandam 2008 Sample Results

				Ammonia	Copper	Nickel	Zinc
Zaandam	R-Class	Zenon	5/14/2008	2.4	52	11.8	99.5
Zaandam	R-Class	Zenon	5/22/2008	12	6.93	9.4	103
Zaandam	R-Class	Zenon	6/5/2008	18	6.16	12.4	108
Zaandam	R-Class	Zenon	6/11/2008	2.2	5.1	6.7	97
Zaandam	R-Class	Zenon	6/19/2008	11	3.49	11.3	30.5
Zaandam	R-Class	Zenon	7/9/2008	5.9	7.81	10.1	51.5
Zaandam	R-Class	Zenon	7/17/2008	12	8.28	12	59.7
Zaandam	R-Class	Zenon	8/14/2008	19	6.4	10	60
Zaandam	R-Class	Zenon	8/15/2008	24	6.2	8.6	68
Zaandam	R-Class	Zenon	8/28/2008	11	6.6	8.4	58
Zaandam	R-Class	Zenon	9/3/2008	1.7	11	9.8	61
Zaandam	R-Class	Zenon	9/11/2008	6.4	3.8	6	3.2

SRE Reporting 2008 2009 HAL [continued]

- Westerdam 2008 Sample Results

				Ammonia	Copper	Nickel	Zinc
Westerdam	Vista	Rochem	5/14/2008	36	ND	5.97	124
Westerdam	Vista	Rochem	5/28/2008	130	6.47	4.69	47.2
Westerdam	Vista	Rochem	6/4/2008	100	1	3.8	23
Westerdam	Vista	Rochem	6/11/2008	130	4.45	8.85	501
Westerdam	Vista	Rochem	7/16/2008	69	1.31	5.29	36.5
Westerdam	Vista	Rochem	8/6/2008	57	ND	4.21	39.5
Westerdam	Vista	Rochem	8/7/2008	67	2.6	6.3	62
Westerdam	Vista	Rochem	8/13/2008	63	3.8	4.8	44
Westerdam	Vista	Rochem	9/3/2008	130	5.6	6.9	44
Westerdam	Vista	Rochem	9/17/2008	110	2.9	8.1	12

SRE Reporting 2008 2009
HAL Laundry Samples

Vessel / sample date	2009 Results ug/L*		
	Laundry Supply	Laundry Drain Tk	Increment
Copper Cu			
Westerdam			
6 17 09	120	240	120
6 24 09	60	140	80
7 8 09	60	125	65
7 15 09	60	125	65
8 5 09	110	160	50
8 26 09	90	120	30
9 2 09	210	290	80
9 16 10	100	150	50
Ryndam			
6 23 09	65	140	75
6 30 09	50	95	45
7 7 09	60	150	90
7 21 09	60	365	305
8 4 09	60	125	65
8 11 09	48	105	57
9 1 09	20	60	40
9 8 09	70	140	70

Vessel / sample date	2009 Results ug/L*		
	Laundry Supply	Laundry Drain Tk	Increment
Nickel Ni			
Westerdam			
6 17 09	14	23	9
6 24 09	6	8	2
7 8 09	6	Missing data point	N/A
7 15 09	4	9	5
8 5 09	5	7.5	2.5
8 26 09	5	5	0
9 2 09	9	11	2
9 16 10	4	7	3
Ryndam			
6 23 09	20	26	5
6 30 09	15	Missing data point	N/A
7 7 09	10	15	5
7 21 09	12.5	17.5	5
8 4 09	12.5	19	6.5
8 11 09	12.5	18	5.5
9 1 09	13	17	4
9 8 09	16	19	3

*Results obtained from 2009 Reported Graph / approximate. Graph not clear / Data value interpretation may not correct. No raw sample data provided by HAL.

SRE Reporting 2008 2009
HAL Laundry Samples

Vessel / sample date	2009 Results ug/L*			
	Laundry Supply	Laundry Drain Tk	Increment	Comments
Zinc Zn				
Westerdam				
6 17 09	240	260	30	
6 24 09	60	90	30	
7 8 09	50	70	20	
7 15 09	80	95	15	
8 5 09	60	90	30	
8 26 09	75	90	15	
9 2 09	100	180	80	
9 16 10	60	120	60	
Ryndam				
6 23 09	60	70	10	
6 30 09	40	110	70	
7 7 09	25	85	60	
7 21 09	85	260	175	
8 4 09	40	110	70	
8 11 09	40	150	110	
9 1 09	45	Missing Data Point	N/A	
9 8 09	75	200	125	

*Results obtained from 2009 Reported Graph / approximate. Graph not clear / Data value interpretation may not correct. No raw sample data provided by HAL.

SRE Reporting 2008 2009
HAL Laundry Ozonator

Vessel / sample date		2009 Results ug/L*			
		Laundry Supply	Laundry Drain Tk	Change	Comments
Ryndam					
12 27 09	Cu	2910	1480	-1480	
	Ni	948	34	-914	
	Zn	3700	246	-3454	
1 3 10	Cu	1180	1600	420	
	Ni	36	23	13	
	Zn	79	167	88	

*Results obtained from 2009 Reported Graph / approximate. Graph not clear / Data value interpretation may not correct. No raw sample data provided by HAL.

SRE Reporting 2008 2009
HAL [continued]

- I (b) Chemical Use / Process Evaluation
  - Identification cleaning products
  - Review Hotel procedures
  - Some products did contain ammonia (floor cleaner)
  - Chemical substitutions made (leaching potential)
  - Drain pipe cleaners (anti scaling chemicals used) dosage system approx. 28.5 ltrs day per vessel. (BW100)
  - Unitor chemicals used in technical department, potable water stabilizer, defoamers.
  - HAL identified that after replacement of chemicals Ammonia treatment is next step.

SRE Reporting 2008 2009
HAL [continued]

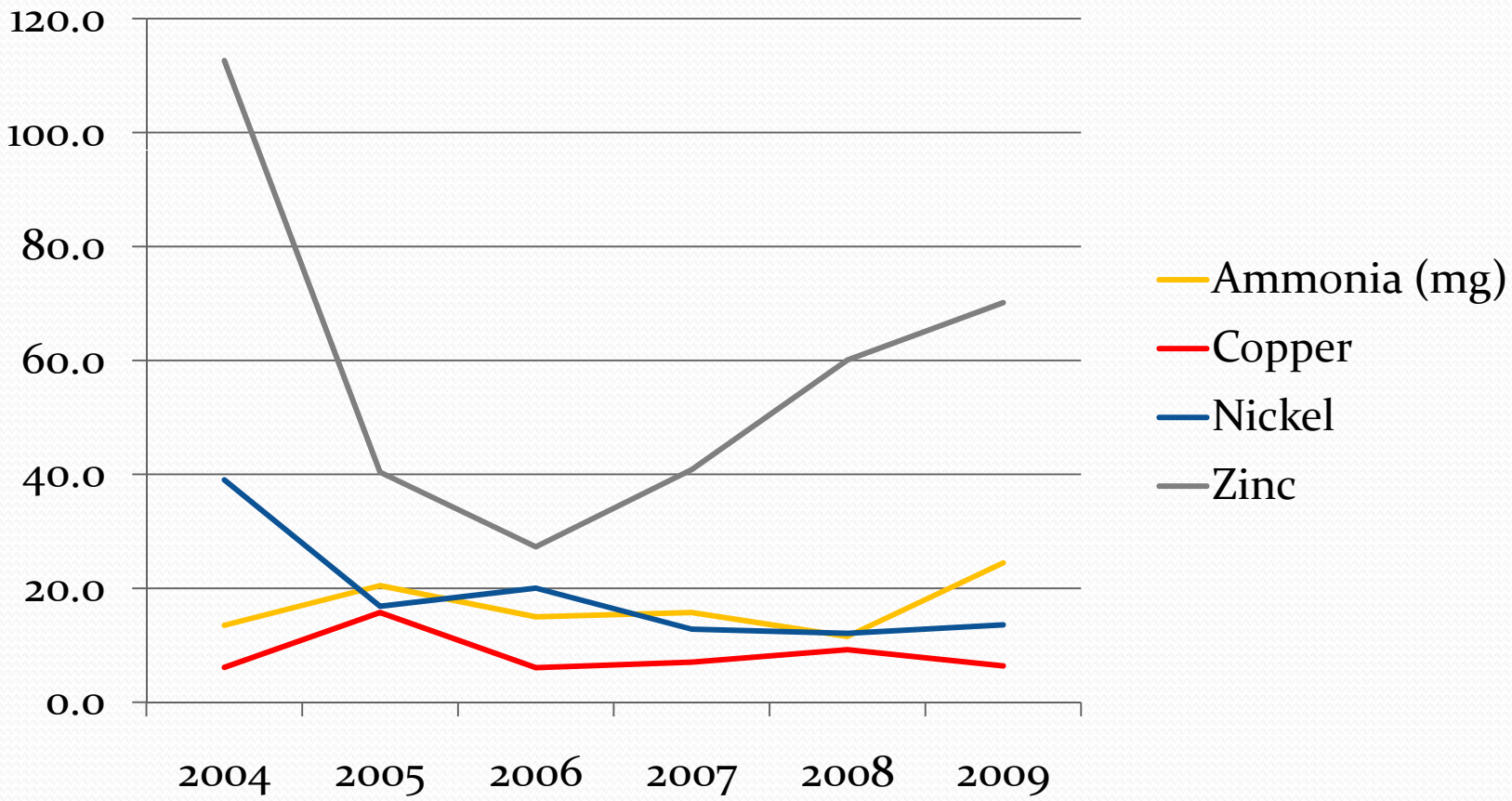
- I (c) Water Supply Evaluation
  - ACA study
- II Treatment Technology Evaluation / Implementation
  - HAL fleet two AWTS systems Rochem & Zenon
    - Rochem system not evaluated in detail in SRE
    - Focus from start on the Zenon system Pilot study II
    - HAL diverted the SRE AWTS efforts to sister company PCL with Hamworthy system
    - HAL BW generation range 40-100 tons day
    - HAL Rochem 2008 ammonia performance was poor, possibly caused by grease fouling air injectors (Westerdam)
    - Rochem (Oosterdam) non-discharger, reason not identified

SRE Reporting 2008 2009
HAL [continued]

- III AWTS Operations / Opti Data
  - HAL investigated nitrification enhancement (additives). End of 2009 sampling showed that the enhancement was not working (poor sample results)
  - GW BW mixing ratio's identified but no detailed process operational (on board) descriptions (table)

Vessel	BW effluent %	GW effluent %	Remarks
Oosterdam	38	62	Rochem AWTS / No discharge in AK in 2008
Westerdam	38	62	Rochem AWTS / Discharge 2008
Ryndam	8	92	Zenon AWTS
Statendam	8	92	Zenon AWTS
Veendam	8	92	Zenon AWTS
Volendam	7	93	Zenon AWTS
Zaandam	7	93	Zenon AWTS

HAL Zenon Averages 2004-2009



SRE Reporting 2008 2009 NCL

- General: Alaska Fleet - 3 vessels (NCL)
  - Vessel overview (Table)

2008 2009 Season:	Vessel Name	Year Delivery	AWTS Type / Units Cap m3	2008 Discharge Status	2009 Discharge Status
	Norwegian Pearl	2006	Scanship / 1780	Yes	Yes
	Norwegian Star	2001	Scanship / 1400	Yes	Yes
	Norwegian Sun	2001	Scanship / 1440	Yes	Yes
Notes: ND=Non Discharger D=Discharger					

NCL Results (Scanship)

Treatment System Type: Scanship

	Ammonia	Copper	Nickel	Zinc
Median	30.0	4.53	7.59	67.10
Average	30.8	6.9	8.8	67.9
Max	71	43	39.2	169
Min	0.31	0.25	3.11	0.5
95th Percentile	50.9	19.72	14	120
99th Percentile	67.96	28.04	21.18	161.08

SRE Reporting 2008 2009 NCL [continued]

- Generally concise, to the point reporting
- I (a) Source Water Evaluation:
  - General discussions
  - Bunker water / Evaporator Water / RO
  - Potable water treated if needed.
  - Piping materials shore connections tanks not identified for all vessels

SRE Reporting 2008 2009 NCL [continued]

- Chemical use Evaporators (Evap treat)
- Carry over of metals in Evaporator from bio fouling system not identified.
- Tank coatings.
- Source sampling performed (Table)
- Indentified soft water and causes (piping), including potential treatment (water balance). NCL Sun poly butylenes piping / NCL Star copper piping.
- Strategic Bunkering OR findings

NCL Source Sampling Results

Vessel	Source	Location	Results* ug/L			Remarks
			Cu	Ni	Zn	
Norwegian Star						
[8/26/08]	Pot Water	Bunker line	1300	-	-	Narrative^
	Pot Water	Evaporator RO plant	No A"	-	-	Narrative
	Pot Water	Everywhere else	280	-	-	Narrative
	Pot Water	Galley	-	20	-	Narrative
	WW untreated	GW BW mixing Tk	-	-	160	Narrative
Norwegian Pearl						
[9/21/08]	Pot Water	Evaporator (no RO)	<40	-	-	Narrative
	WW untreated	GW BW mixing Tk	1300	1200	-	Narrative
Norwegian Sun						
[8/20/08]	Pot Water	Evaporator (no RO)	<100	-	-	Narrative
	WW untreated	Influent AWTS	310	-	-	Narrative

Note: - = no data / narrative provided. ^ = Mystery value; NCL no copper piping. " = No copper added.

SRE Reporting 2008 2009 NCL [continued]

- I (b) Chemical Use / Process Evaluation
  - Identification cleaning products
  - Use of Swisher Bio products in toilet care etc.
  - Ecolab products are on “alkaline basis” no metals.
  - Bio organic cleaners used as well
  - Review Hotel procedures
  - Chemical substitutions made (leaching potential)
  - Drain pipe cleaners (anti scaling chemicals) usage (volume) not identified (Unitor brand).
  - EVAC de-foamer used (ether alcohol).

SRE Reporting 2008 2009
NCL [continued]

- II Treatment Technology Evaluation / Implementation
  - NCL AWTS systems Scanship
    - NCL AWTS Scanship pioneer
    - Scanship system in detail evaluated in SRE
    - Focus from start was on Ammonia
    - SRE action plan from outset and focusing on results
    - NCL BW generation range 60-100 tons day
    - NCL Scanship 2008 / 2009 ammonia performance
    - OR findings in 2008 2009 NCL appears very actively working on the AWTS systems.

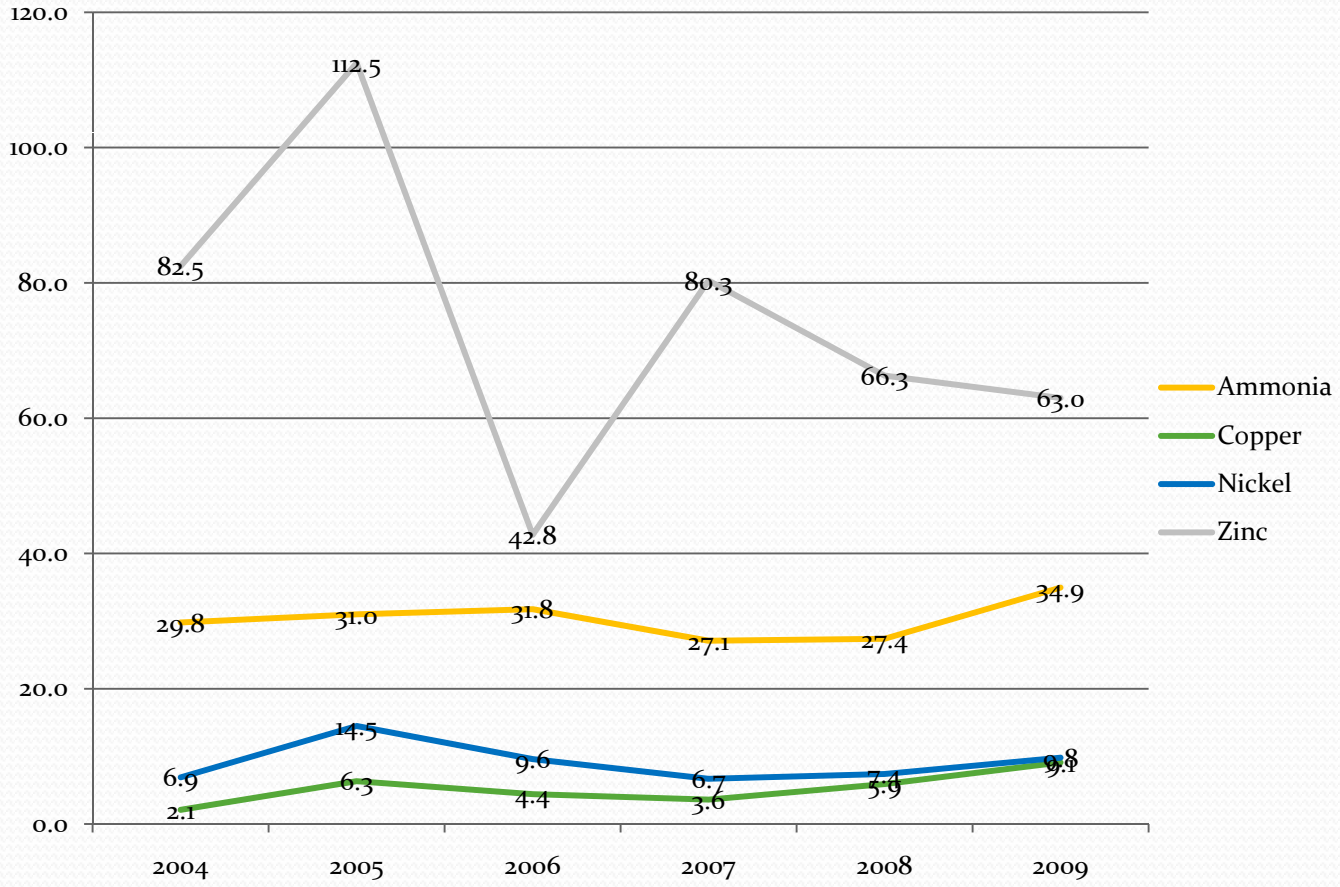
SRE Reporting 2008 2009
NCL [continued]

- NCL provided actions plans and “worse case scenarios”
- NCL provide confidential information
- Phase I: Nor Pearl and Nor Star if AWTS modifications works then other vessels included.
  - Bio reactor modifications
  - Coagulant smart use / organic type
  - Residence time
  - New bio media surfaces
  - Increase Oxygen ratio

SRE Reporting 2008 2009

NCL [continued]

Trends 2008 2009



SRE Reporting 2008 2009
Seven Seas Mariner

- General: 1 vessel

2008 2009 Season:	Vessel Name	Year Delivery	AWTS Type / Units Cap m3	2008 Discharge Status	2009 Discharge Status
	Seven Seas Mariner	2001	Hamworthy 240C 360 [2 x 180]	D	D

- Detailed concise to the point SRE reporting
- 1(a) Source Water Evaluation:
  - General discussions
  - Bunker water / Evap water
  - Evap systems identified
  - Distribution system materials breakdown.
  - Vessel actively tracked metal sources and started replacement of piping.

Seven Seas Mariner piping

BW system	Material	GW system	Material	Potable water	Material
Toilets/ urinals / hospital /drain sink	Stainless steel	Sink / drain / baths / shower / suite	Stainless steel	Distribution system	Copper
		Galley sink drains		Bunkering / engine spaces	Galvanized steel
		Pulpers		**Technical water**	Galvanized steel / copper
		Laundry sinks drains			
		Jacuzzis			

SRE Reporting 2008 2009
Seven Seas Mariner [continued]

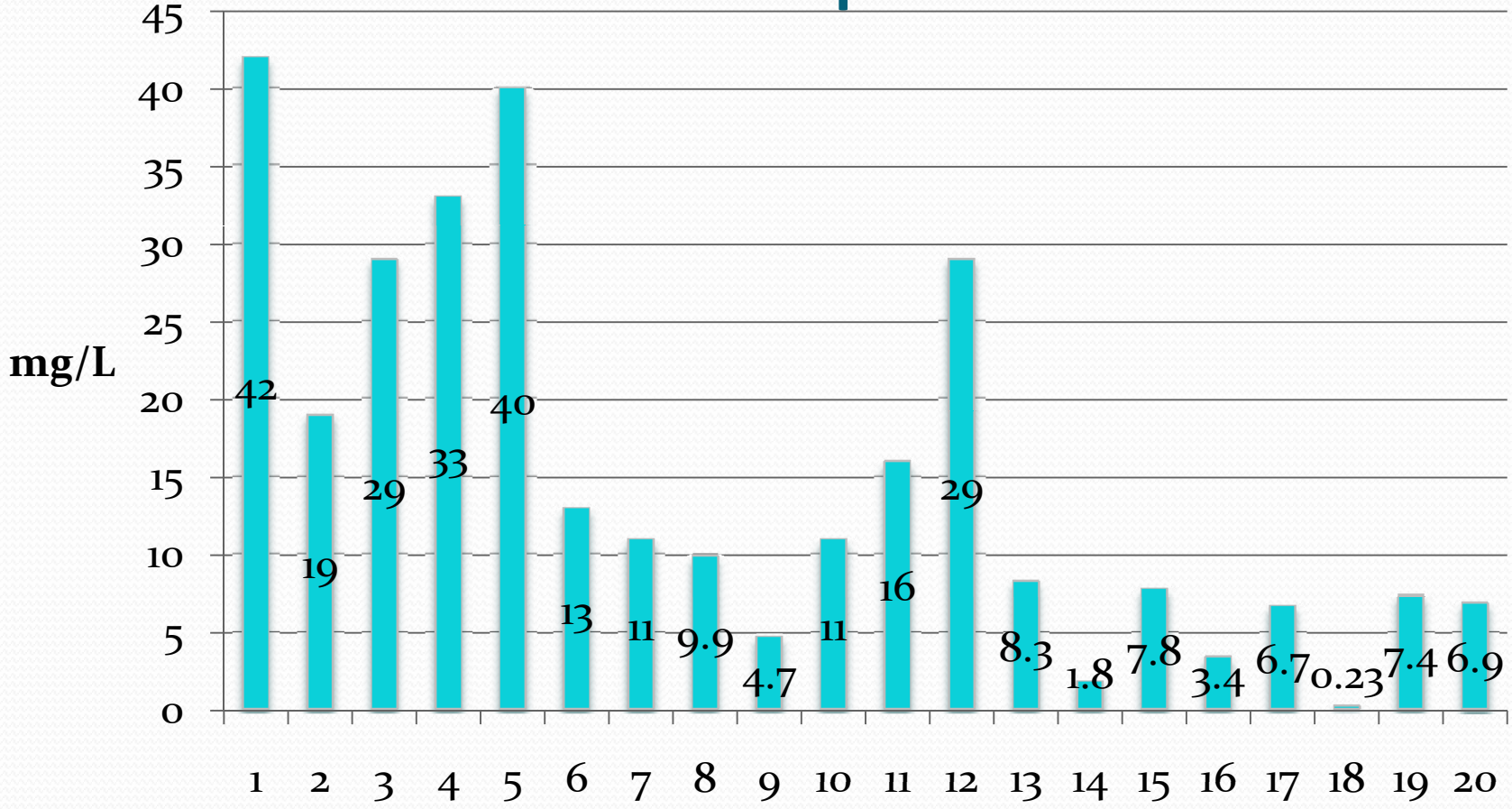
- I (b) Chemical Use / Process Evaluation
  - Identification cleaning products
  - Sodium Hypochlorite used in pool Jacuzzi (identified)
  - Bio organic cleaners used as well
  - Review Hotel procedures
  - Chemical substitutions made (leaching potential)
  - Drain pipe cleaners (anti scaling chemicals) usage (volume) not identified but used quarterly (Bio Scale Zapper).
  - Reduction of laundry detergents, more efficient use.

SRE Reporting 2008 2009 Seven Seas Mariner [continued]

- II Treatment Technology Evaluation / Implementation
  - Seven Seas Hamworthy systems
    - SSM Hamworthy good results
    - Relatively better Ammonia results than PCL Hamworthy AWTS
    - Focus from start on the vessel system metals
    - SRE action plan from outset and focusing on results
    - BW GW ratio about 5%BW 95%GW
    - SSM 2008 / 2009 ammonia metal performance (next table)
    - Metal spikes (zinc) in effluent corrected by storing boilerwater in tanks for offshore discharge.
    - AWTS Hamworthy units are operated not at maximum operation load.

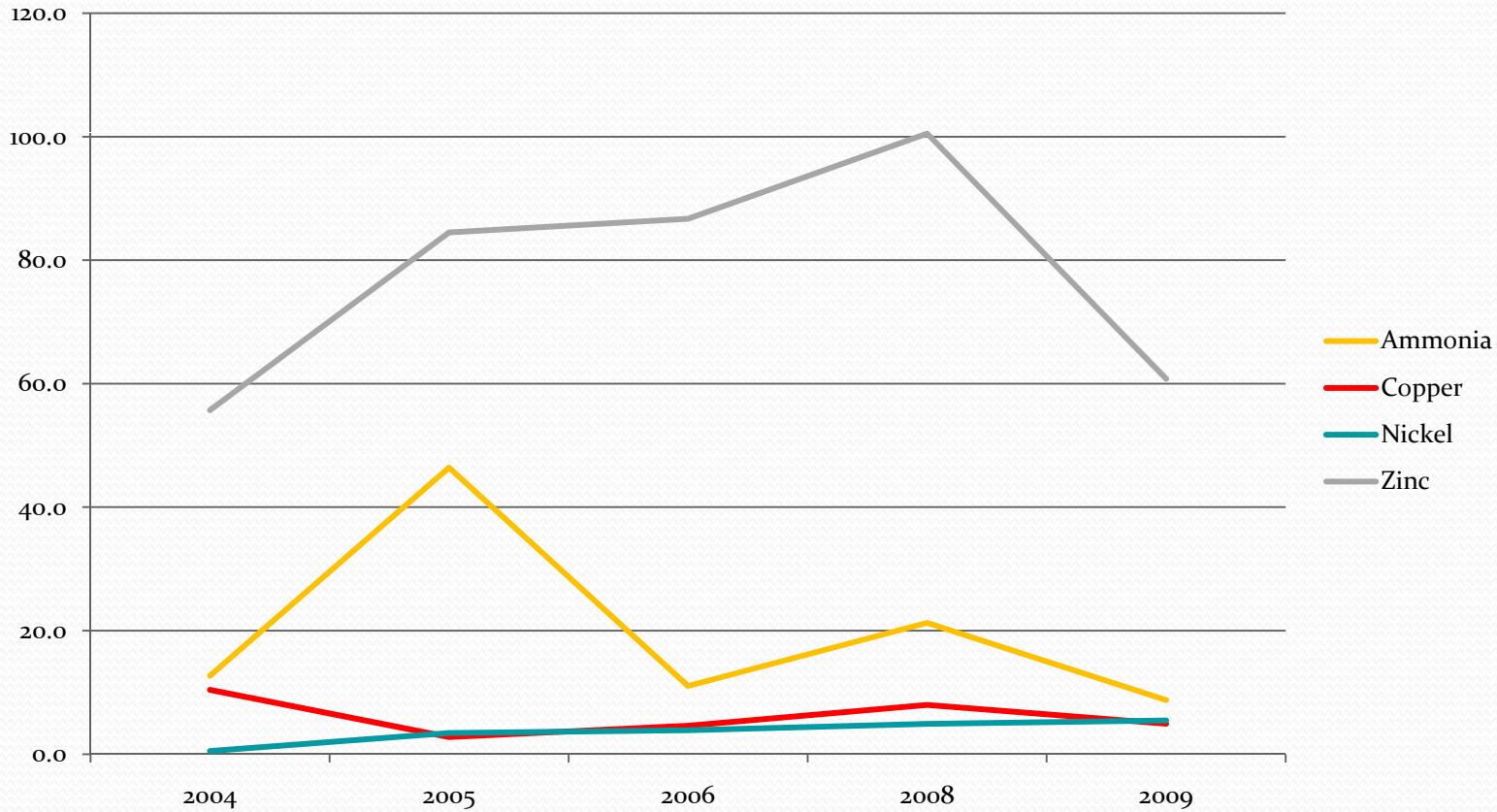
    - OR findings in 2008 2009 SSM appears very actively working on the AWTS systems and vessel piping systems.

Seven Seas Mariner 2008-2009 Ammonia WW Sample Results



Note 1-10 in 2008, 11-20 in 2009

Seven Seas Mariner



SRE Reporting 2008 2009
Silver Shadow

- General: 1 vessel
- Vessel overview (Table)

2008 2009 Season:	Vessel Name	Year Delivery	AWTS Type / Units Cap m3	2008 Discharge Status	2009 Discharge Status
	Silver Shadow	2000	Marisan Biopure 300 [2 x 25 / 250]	D	D

Silver Shadow WW sampling

Treatment System Type: Marisan

	Ammonia	Copper	Nickel	Zinc
Median	0.3	52.0	13.9	21.0
Average	1.8	48.6	13.4	25.6
Max	23.0	172.0	24.1	125.0
Min	0.1	3.8	5.7	0.5
95th Percentile	7.2	97.0	23.1	61.4
99th Percentile	19.7	157.0	23.9	112.3

SRE Reporting 2008 2009 Silver Shadow [continued]

- Detailed concise to the point SRE reporting
- 1(a) Source Water Evaluation:
  - General discussions
  - Bunker water / Evap water
  - Evap systems identified
  - Distribution system reviews “hammering “ etc.
  - Direct repairs made and replacement of “suspect” piping corroded piping. For 2011 extended dock plans.
  - Vessel actively tracked metal sources and started replacement of piping.
  - Started with “on board lab” to do metal investigations

SRE Reporting 2008 2009
Silver Shadow [continued]

- SS actively monitors corrosion of piping and other parts.
- Own sampling done on bunker water
- SS tried to correlate bunker water with metal source
- SS found out Seattle / Vancouver and Skagway are bunker ports with metal loads.
- Strategic monitoring bunker regime.
- Copper source were identified (laundry) and not discharged in Alaska.
- Preliminary SS controls technical water quality with water treatment ? (uncertain)

Silver Shadow [continued]

Source Samples

Location Date 6 /6/08 9/8/08	Cu ug/L	Ni ug/L
Evap I PS	17.7	4.18
	55	29
Evap II ST	19.9	5.42
	32	8.0
RO tank	-	-
	5.3	2.5
FWD tank 3SB infl.	0.602	2.24
	-	-
Domestic Heater outlet	-	-
	30	57
GW inlet Marisan	-	-
	110	11
Deck 3 Hot Water	26.1	16.6
	35	9.1
Deck 5 Cold Water	6.38	1.59
	18	3.0
Deck 9 Hot Water	25.9	17.2
	40	8.6
FW Bunker station	0.345	<0.15
	-	-
FW Tank 4 ST	2.25	1.29
	-	-

SRE Reporting 2008 2009
Silver Shadow [continued]

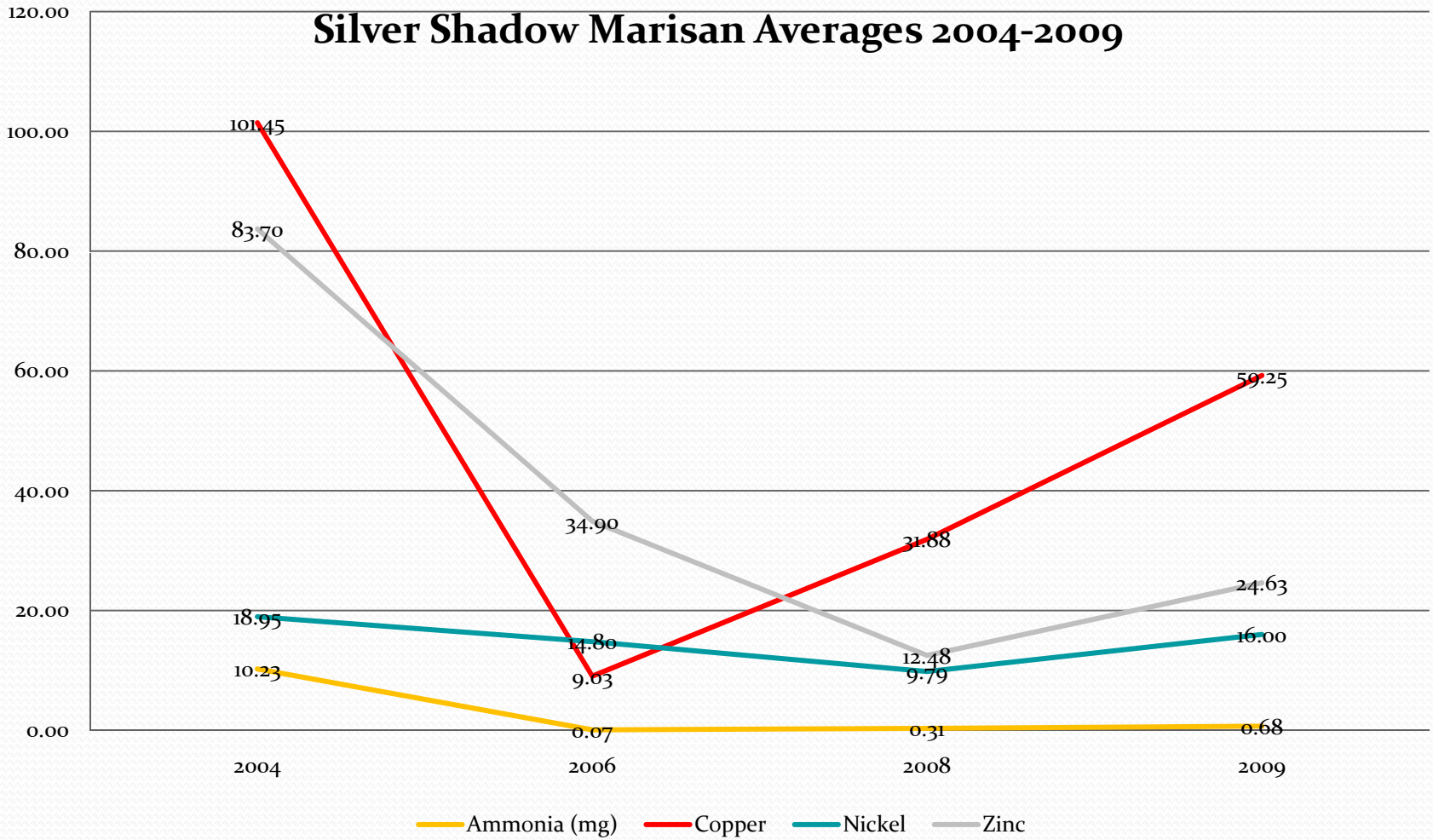
- I (b) Chemical Use / Process Evaluation
  - Identification cleaning products
  - Review Hotel procedures
  - Process evaluation for new products will continue
  - All paints that contained “copper pigments” in coating are re-coated with solvent free amine cured epoxy coating.

SRE Reporting 2008 2009
Silver Shadow [continued]

- II Treatment Technology Evaluation / Implementation
  - Silver Shadow systems
    - Silver Shadow Marisan System appears to have good effluent performance (good results)
    - Vessel appears actively working on AWTS improvements.
    - Silver Shadow identified that upgrade possibilities are not possible.
    - Vessel continues actively working on corrosion piping and parts exchange and corrosion controls.

    - OR findings in 2008 2009 it appeared they were very actively working on the AWTS systems and vessel piping systems.

Silver Shadow



SRE Reporting 2008 2009 Carnival Cruise Line

- General: 1 Alaska bound vessel
- Vessel overview (Table)

2008 2009 Season:	Vessel Name	Year Delivery	AWTS Type / Units Cap m3	2008 Discharge Status	2009 Discharge Status
	Carnival Spirit	2001	Rochem 740 (GW)	D [only GW]	D [only GW]
Notes: ND=Non Discharger D=Discharger *=Vessels that participated in SRE Reporting per season.					

Carnival Spirit 2008-2009 GW

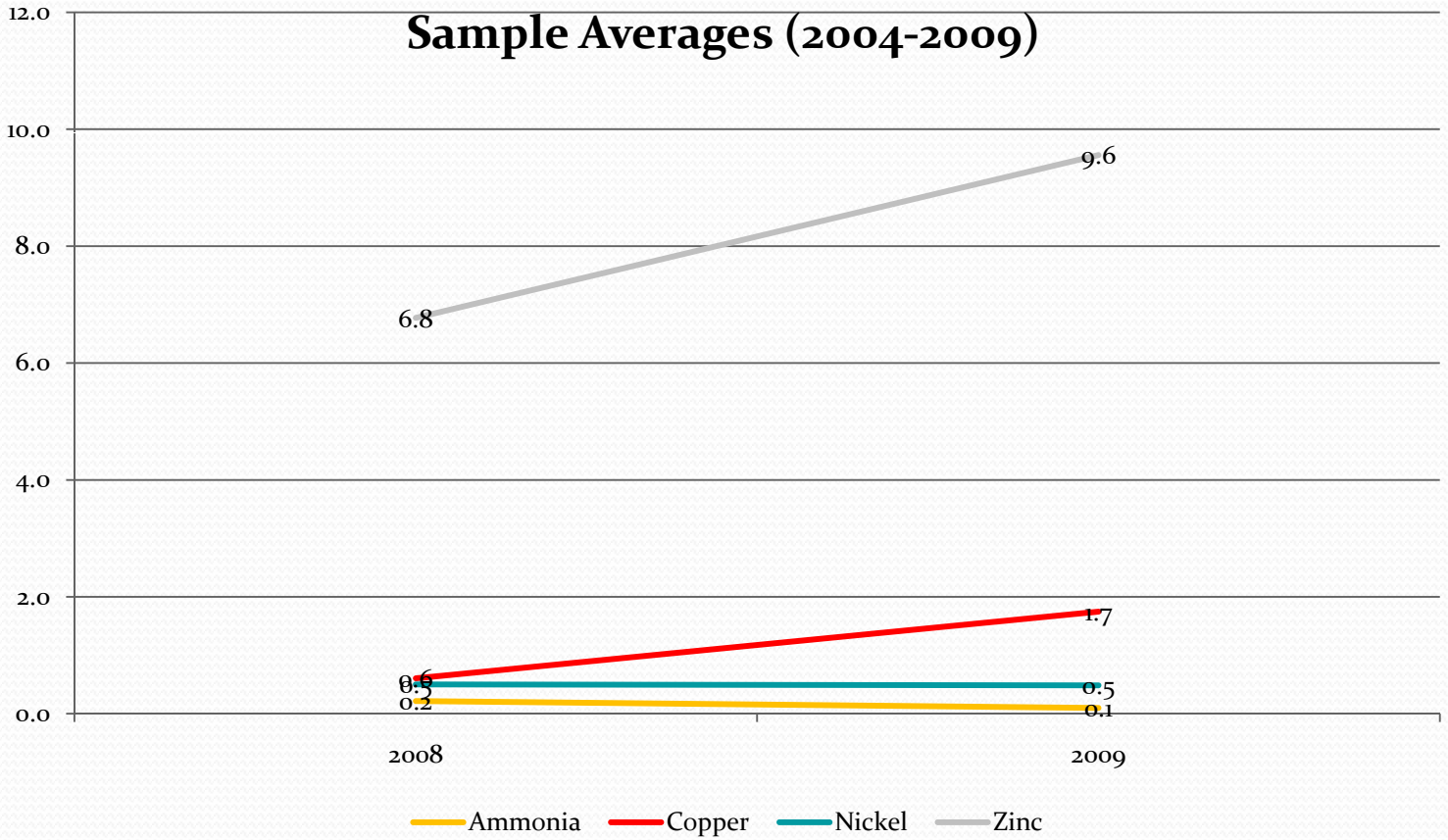
Treatment System Type:	Rochem			
	Ammonia	Copper	Nickel	Zinc
Median	0.1	0.6	0.5	6.4
Average	0.1	1.4	0.5	8.8
Max	0.5	11.7	1.4	32.4
Min	0.1	0.3	0.2	2.9
95th Percentile	0.1	6.2	0.9	21.1
99th Percentile	0.1	10.7	1.3	30.3

SRE Reporting 2008 2009 Carnival [continued]

- Waste stream selected GW only
- Piping shore bunker connection tank provided

Vessel	Evaporator Average day m3/day	RO water maker Cap day m3/day	Average condensate TG m3/day	Bunker Ports AK loading Volume %	Bunker Port Vancouver Volume %
Carnival Spirit	1200 [2x600]	NP	NP	75	25
2008					
Treated waste water discharged volumes 2008 m3		July	September	August	
Carnival Spirit		310	434	967	
*Note: NP = NP Provided and Alaska Bunker Ports not identified					

Carnival Spirit 2008-2009



SRE Reporting 2008 2009
Royal Caribbean Cruises Ltd.

- General: Alaska fleet 6 vessels (2008 and 2009)
- Vessel overview (Table)

	Vessel Name	Year Delivery	AWTS Type / Units Cap m3	2008 Discharge Status	2009 Discharge Status
	Celebrity Infinity *	2001	Zenon	ND	ND
	Celebrity Millennium*	2001	Hydroxyl	ND [only discharged to sample for a study]	ND
	Serenade of the Seas*	2003	Scanship	ND	Yes Discharger (D)
	Radiance of the Seas*	2001	Hydroxyl	ND	ND
	Rhapsody of the Seas*	1997	Navalis [under construction]	ND	ND
Notes: ND=Non Discharger D=Discharger *=Vessels that participated in SRE Reporting per season.					

Serenade of the Seas 2009

Sample Results- Scanship

Vessel	Treatment System	Wastewater Type	Sample Date	mg/L Ammonia	ug/L Copper	ug/L Nickel	ug/L Zinc	S.U. pH	col. per 100 ml Fecal Coliform	mg/L TSS	mg/L BOD	mg/L Chlorine
Serenade	Scanship	Mixed	5/21/2009	28	2.98	9.61	102	6.8	9.47	13	11.8	ND
Serenade	Scanship	Mixed	5/28/2009	17	3.93	17.2	141	6.9	ND	16	8.54	ND
Serenade	Scanship	Mixed	6/4/2009	23	3.79	10.6	94.5	6.9	ND	6	2.92	ND
Serenade	Scanship	Mixed	6/25/2009	16	3.02	12	94	6.8	ND	12	5.89	ND
Serenade	Scanship	Mixed	7/2/2009	23	3.84	12.5	133	6.9	ND	ND	2.15	ND
Serenade	Scanship	Mixed	7/23/2009	16	4.96	22.1	135	7	ND	5	2.66	ND
Serenade	Scanship	Mixed	8/6/2009	23	3.7	12.4	267	6.8	ND	10	4.87	ND
Serenade	Scanship	Mixed	8/20/2009	14	5.02	9.13	60.3	7	ND	4	5.66	ND
Serenade	Scanship	Mixed	9/17/2009	15	8.15	28.2	77.8	6.9	ND	4	ND	ND
Serenade	Scanship	Mixed	9/24/2009	10	4.71	21.1	81.4	6.8	ND	5	3.06	ND

SRE Reporting 2008 2009 Royal Carribean [continued]

- I(a) Source Water Evaluation:
  - Bunker water / RO produced water
  - Piping identified, corrosion control discussed
  - Started with “on board lab” to do metal investigations
- I (b) Chemical Use / Process Evaluation
  - Identification cleaning products
  - Review of pesticide use

SRE Reporting 2008 2009
Royal Caribbean [continued]

- II) Treatment Technology
- Three types of treatment systems (Scanship, Zenon, Hydroxyl)
- BW/GW mixing ratio 1:12 to 1:20
- Rhapsody of the Seas selected for new AWTS system- *Navalis*. Installation still ongoing.

SRE Reporting Royal Caribbean

[continued]

Vessel	Evaporator Average day m3/day	RO water maker Cap day m3/day	Average condensate TG m3/day	Bunker Ports AK loading m3 / week	Total Water Made m3/day	% Volume Bunker m3/day	Total Volume Water m3/day
Celebrity Infinity	Serck 760	Desal 0	10-15	N/a	775	0%	775
Celebrity Millennium	Serck 225	Desal 0	0	3670*	225	70%	750
Radiance of the Seas	Alfa 600	Desal 400	0	133 JNU 504 KTN 411 SKG 730 VAN	1,000	10%	1,150
Serenade of the Seas	Alfa Laval 650	Desal 350	0	75 SKG 250 VAN	1,000	4.5%	1,046
2009 Update							
Serenade of the Seas ^	Alfa Laval 650	Desal 0	0	400 SKG! 400 JNU!	650	14%	764

*Note: Bunker Ports not identified / JNU=Juneau / KTN=Ketchikan /SKG=Skagway / VAN=Vancouver [BC] ^= Data confirmed by RCL for 2009 season. ! = Not identified per period week day?

Questions?