

Source Reduction Evaluation

2008 2009

Part I

For Science Panel

ADEC 2010



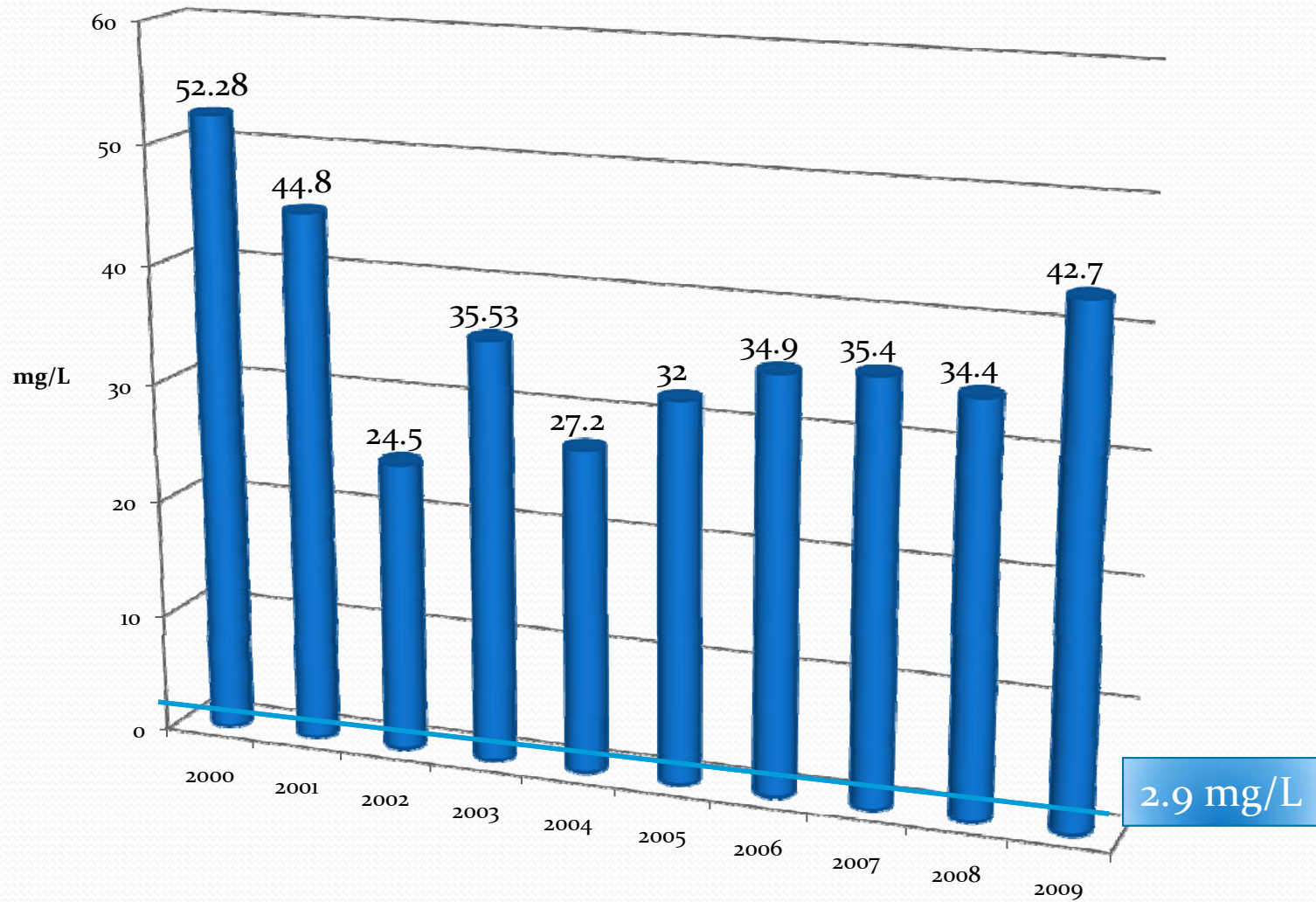
Source Reduction Evaluations

- Requirement of 2008 General Permit for interim limits for ammonia, copper, nickel, and zinc
- Two year program to transition to original 2010 long-term limits

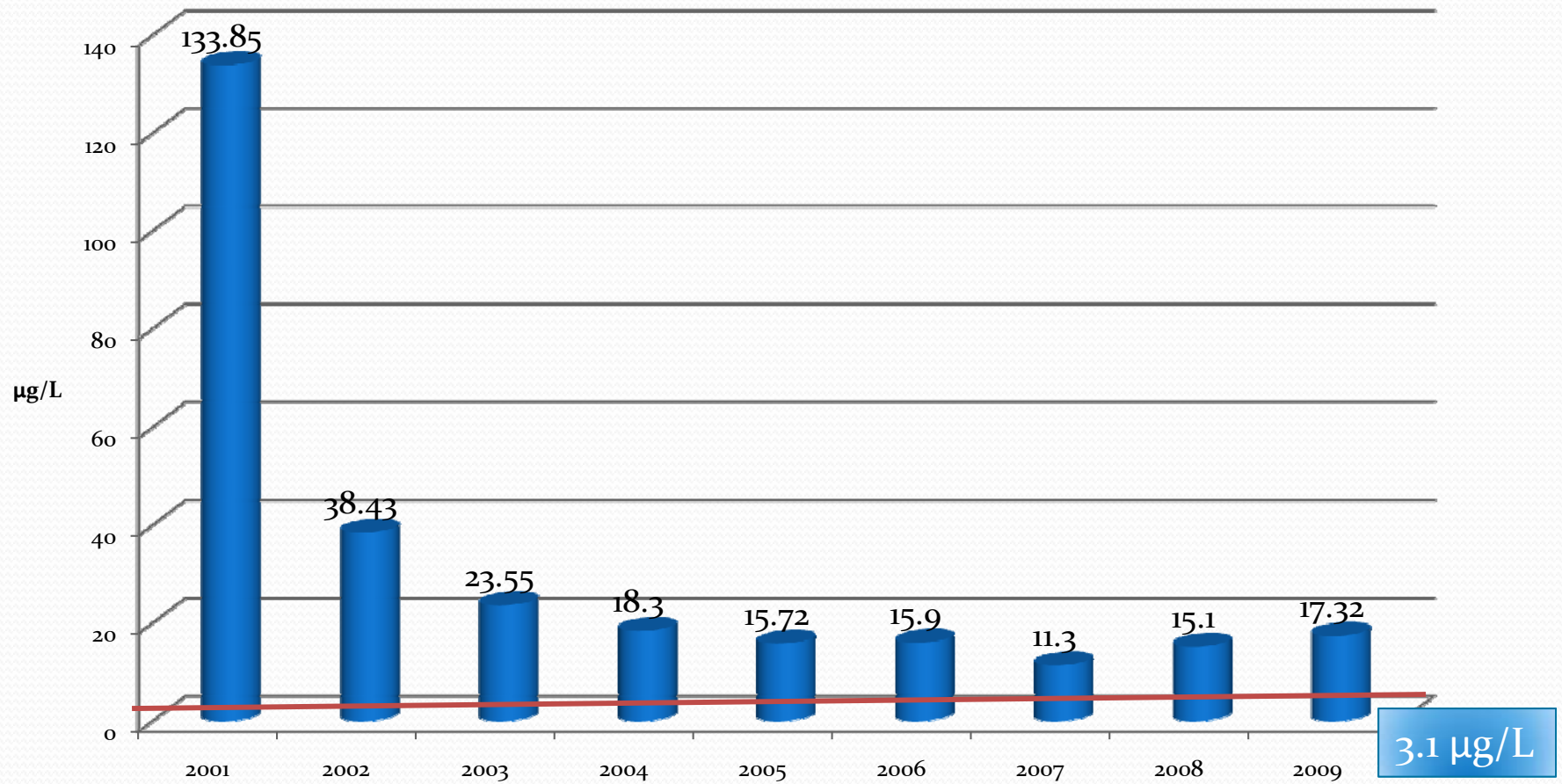
Interim Limits (required SRE)

Ammonia		Copper	
interim (mg/L) 80.4	long term (mg/L) 2.9	interim (ug/L) 66	long term (ug/L) 3.1
Nickel		Zinc	
interim (ug/L) 180	long term (ug/L) 8.2	interim (ug/L) 230	long term (ug/L) 81
pH		Biological oxygen demand (BOD)	
Minimum 6.5	Maximum 8.5	Maximum 60 mg/L	Monthly Average 30 mg/L
Fecal Coliform			
Maximum 43/ 100 ml	Monthly Average 14/ 100 ml		
Total Suspended Solids (TSS)		Total Residual Chlorine	
Maximum 150 mg/L		Maximum 0.0075 mg/L	

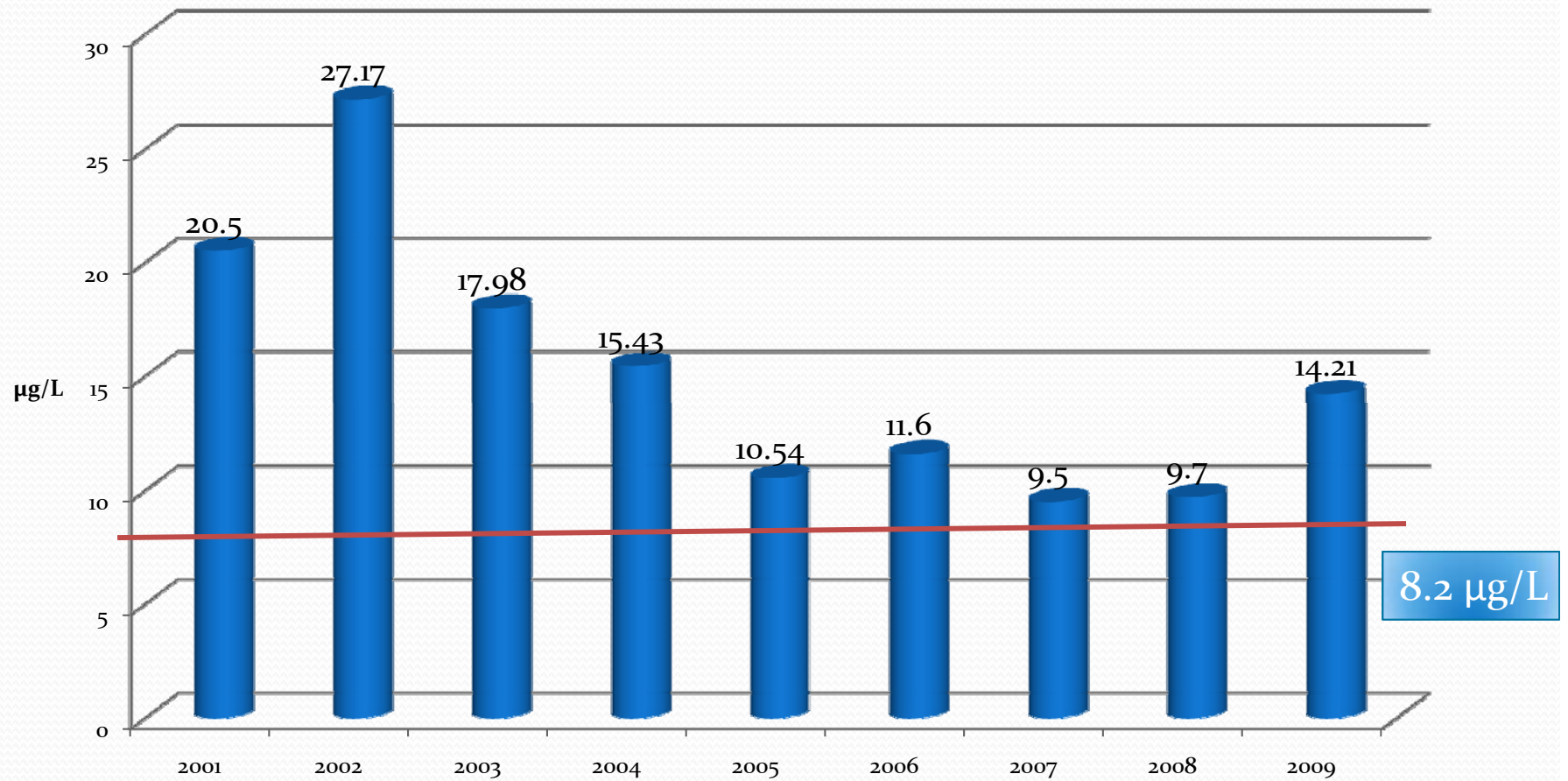
Ammonia Averages 2000-2009



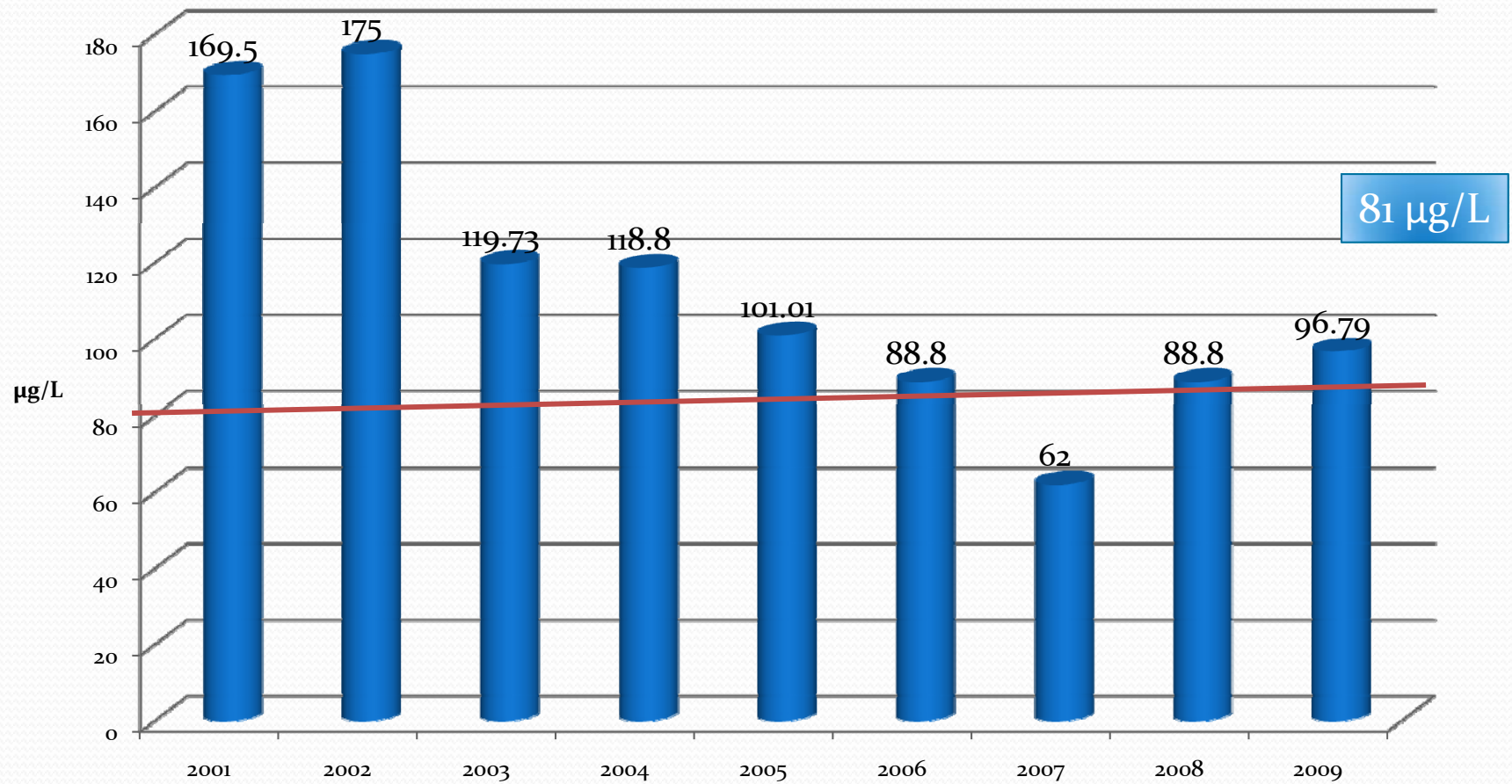
Copper(Dissolved)



Nickel (Dissolved)



Zinc (Dissolved)





Source Reduction Evaluation (SRE) Players

- The following cruise lines provided SRE reports:
 - Holland America Line (HAL) (member of the CCL group)
 - Princess Cruise Line (PCL) (member of the CCL group)
 - Carnival Spirit (CCL) (Member of the CCL group)
 - Norwegian Cruise Lines (NCL)
 - Royal Caribbean Cruises (RCL)
 - Seven Seas Mariner (Regent Cruise Lines)
 - Silver Shadow (Silversea Cruises)

SRE

VESSEL PARTICULARS

2010 Large Commercial Passenger Vessel Discharge Status and Wastewater Treatment

Vessel Operator	Vessel Name	Passenger Capacity	Voyages	Total Passengers ⁵	Crew Capacity	Total Persons on Board ²	Blackwater (BW) Treatment System Manufacturer
Carnival Cruise Lines	<i>Carnival Spirit</i>	2500	19	47,500	934	3434	Triton/Rochem
Celebrity Cruises	<i>Infinity</i>	2449	19	46,531	930	3379	Zenon
Celebrity Cruises	<i>Mercury</i>	1876	19	35,644	909	2785	Biopure/Rochem
Celebrity Cruises	<i>Millennium</i>	2449	19	46,531	1001	3450	Hydroxyl Cleansea
Holland America	<i>Amsterdam</i>	1380	11	15,180	647	2027	Unknown
Holland America	<i>Oosterdam</i>	1916	20	38,320	800	2716	Rochem Bio-filtration
Holland America	<i>Rotterdam</i>	1404	18	25,272	Unknown	1404+crew	Unknown
Holland America	<i>Ryndam</i>	1260	19	23,940	602	1862	Zenon
Holland America	<i>Statendam</i>	1260	19	23,940	588	1848	Zenon
Holland America	<i>Volendam</i>	1432	19	27,208	647	2079	Zenon
Holland America	<i>Zaandam</i>	1432	20	28,640	647	2079	Zenon
Holland America	<i>Zuiderdam</i>	1916	20	38,320	Unknown	1916+crew	Rochem Bio-filtration
Japan Cruise Line	<i>Pacific Venus</i>	680	1	680	Unknown	680 + crew	Unknown
Mitsui OSK	<i>Nippon Maru</i>	539	1	539	Unknown	539+Crew	Unknown
Norwegian Cruise Lines	<i>Norwegian Pearl</i>	2394	20	47,880	1100	3494	Scanship
Norwegian Cruise Lines	<i>Norwegian Star</i>	2348	22	51,656	1100	3448	Scanship
NYK	<i>Asuka II</i>	872	1	872	Unknown	872+Crew	Unknown
Princess Cruise Line	<i>Coral Princess</i>	1970	19	37,430	900	2800	Hamworthy Bioreactor
Princess Cruise Line	<i>Diamond Princess</i>	2678	20	53,560	1238	3916	Hamworthy Bioreactor
Princess Cruise Line	<i>Golden Princess</i>	2598	19	49,362	1060	3658	Hamworthy Bioreactor
Princess Cruise Line	<i>Island Princess</i>	1970	18	35,460	900	2870	Hamworthy Bioreactor
Princess Cruise Line	<i>Royal Princess</i>	710	8	5,680	374	1062	Hamworthy Bioreactor
Princess Cruise Line	<i>Sapphire Princess</i>	2678	18	48,204	1238	3916	Hamworthy Bioreactor
Princess Cruise Line	<i>Sea Princess</i>	2016	13	26,208	854	2870	Hamworthy Bioreactor
Prestige Cruises	<i>Seven Seas Navigator</i>	540	14	7,560	350	890	Scanship
Royal Caribbean Cruises	<i>Radiance of the Seas</i>	2501	18	45,018	859	3360	Hamman
Royal Caribbean Cruises	<i>Rhapsody of the Seas</i>	2435	19	46,265	Unknown	2435+crew	Hamman
Silver Seas	<i>Silver Shadow</i>	382	16	6,112	305	687	Biopure/Marisan

Source Reduction Evaluation (SRE)

Elements in a Nutshell

- ADEC provided simple guidelines for SRE contents & expectations. The GP include SRE conditions.
- Operator's responsibility to provide report and implement actions for reduction of ammonia and metals and any further actions & reporting
- Most operator's reporting formats were different.
- All SRE reports were reviewed by ADEC staff. If necessary questions were asked to clarify some reported items.

Source Reduction Evaluation (SRE)

Elements in a Nutshell [continued]

- The SRE reports provided by the vessels included these elements (generally):
 - I) Influent Source Reduction
 - Source water evaluation
 - Chemical use evaluation
 - Water supply evaluation
 - II) Treatment technology evaluation / Implementation
 - III) AWTs Operations Optimization

Ship Operations / Systems I

Potable Water

- Vessels use potable water (drinking water) for cleaning, food preparation, for laundry/wash operations, flush operations, bath wash, drinking water, and for technical process (e.g. cooling water / steam generation)
- Water use can be divided into Hotel use (pax crew) and Technical Department use
- Water can be produced onboard by desalination of seawater

Ship Operations / Systems I

Potable Water [continued]

- Onboard produced water can be obtained by:
 - Evaporator systems
 - Reverse Osmosis systems
 - Collection of condensate / permeate (Technical Water)
- Water can be loaded (bunkered) from trusted shore side facilities. This water is called “bunker water”
- Water produced / bunker water is treated onboard (“sanitized / chlorination”)
- Water that is produced on board or bunkered is stored onboard in dedicated water tanks.

Ship Operations / Systems I

Potable Water [continued]

- From these water tanks the water is distributed to the vessel's consumers through piping (distribution) system.
- Distribution system vertical piping “columns” to bring the water to the next level / deck are sometimes called “risers”
- Piping materials differ: Copper / stainless / metal free piping (plastics) / fitting stainless steel metallic.
- Drain piping from “consumer” to collecting tanks metallic piping (galvanized) / non-metallic piping.

Ship Operations / Systems I

Waste Water

- General Definitions:
 - Black water (BW) and Gray Water (GW)
 - Influent is the BW / or GW that enters the waste water treatment system
 - Collecting Tanks collect the BW or GW flows
 - Effluent is the BW and or GW flow that is discharged overboard or discharged in holding tanks

Ship Operations / Systems I

Waste Water [continued]

- BW generated from toilets. Toilet systems are vacuum systems (water conservation).
- Toilet flush water (conveyance water) on some vessels is technical water.
- BW collecting system dedicated systems / collecting tanks
- GW collection system dedicated systems / collecting tanks
- GW generated from Hotel- galleys, laundry, cabins, cleaning stations.
- BW flow relatively small compared to GW volumes (influent)
- GW flow the majority of the wastewater flow volume (influent)

Ship Operations / Systems I

Waste Water [continued]

- Boiler water generated from steam boiler system (engine room)
- Spa, Jacuzzi, Pool water generated from the Hotel systems (hotel).
- Other wastewater sources

Ship Operations / Systems I

Waste Water Treatment

- Wastewater treatment systems are a Marine Sanitation Device MSD II, but a very advanced one. Therefore we call these systems Advanced Wastewater Treatment Systems (AWTS)
- All vessels that participated in SRE Reporting have AWTS systems.
- AWTS system are currently designed to remove the “conventional” pollutants (e.g. Fecal, BOD, TSS etc) not metals.

Ship Operations / Systems I

Waste Water Treatment [continued]

- AWTs systems used:
 - Zenon System: Membrane Bioreactor (MBR) system
 - Hamworthy: Membrane Bioreactor (MBR) system
 - Scanship: Bioreactor with flotation/polishing
 - Rochem: RO and ultra filtration system
 - Biopure Marisan: Bioreactor with microfiltration



ACA Bunker Water Samples

- Referenced in most cruise line SREs
- DEC had questions regarding QA/QC of sampling
- Most sample events not correlated to vessels bunkering water
- Wide range of results for different weeks, or nearby locations
- Some samples shown in following tables from Princess SRE efforts.

ACA Bunker Water Samples

- Sample Locations

Port	Cu Ni Zn	Qty	Notes
San Francisco	Yes	7	
Seattle	Yes	23	
Victoria [BC]	Yes	12	
Vancouver [BC]	Yes	28	
Ketchikan	Yes	21	
Wrangell	Yes	1	ACA was not aware of 2008 cruise ship visits
Juneau	Yes	24	
Haines	Yes	1	ACA was not aware of 2008 cruise ship visits
Skagway	Yes	23	
Whittier	Yes	6	
Seward	Yes	6	

ACA Bunker Water Sample Results

Part 1

Port Location	Date	Cu ug/L	Ni ug/L	ZN ug/L	Notes
San Francisco	7/16/08	0.83	<0.5	<5	PCL sample
San Francisco Pier 35	8/26/08	3.4	<0.5	250	ACA sample
Seattle North Berth PCL	6/30/08	34	1.3	2600	PCL sample
Victoria Pier A south	8/26/08	7.0	<1	<5	ACA sample
Victoria Pier B North	8/26/08	7.0	<1	16	ACA sample
Victoria	6/21/08	2.47	0.431	8.92	PCL sample
Victoria	6/5/09	2.6	2.8	120	PCL sample
Vancouver North Con	7/24/08	1.5	<0.2	209	PCL sample
Vancouver Central Con	7/24/08	15	<0.2	280	PCL sample
Vancouver South Con	7/24/08	7.8	<0.2	6.0	PCL sample
Vancouver Can Place East	8/27/08	110	<1.0	<5	ACA sample
Vancouver Can Place West	8/27/08	4.0	<1.0	12	ACA sample
Ketchikan	6/17/08	3.62	0.212	4.14	PCL sample
Ketchikan St. FWD Port	6/17/08	0.43	0.2	6.49	PCL sample
Ketchikan Berth 2	8/29/08	<1	<1	3.4	ACA sample
Ketchikan Berth 4	8/29/08	2.2	<1	10	ACA sample
Ketchikan Berth 3	8/29/08	1.3	<1	16	ACA sample

Note: Selected from Princess Cruise Lines SRE Reporting (08/09) and ACA Bunker water Synopsis 2008.

ACA Bunker Water Sample Results

Part 2

Port Location	Date	Cu ug/L	Ni ug/L	ZN ug/L	Notes
Juneau AJ Dock	6/18/08	28.1	1.24	13.7	PCL sample
Juneau AJ Dock	7/21/08	58.4	0.771	26.8	
Juneau South Franklin dock	6/25/08	41.7	2.35	16	PCL sample
Juneau South Franklin dock	6/1/09	2.2	1.3	33	PCL sample
Juneau South Franklin Dock	8/18/08	280	2.9	77	ACA sample
Juneau South Franklin Dock	8/11/08	2.3	0.46	13	ACA sample
Juneau AK SS dock	9/4/08	34	1.2	75	ACA sample
Skagway	6/12/08	0.688	1.48	6.53	PCL sample
Skagway	6/2/09	3.2	1.5	49	PCL sample
Skagway RR dock	8/26/08	20	22	54	ACA sample
Skagway Ore station Dock	8/26/08	2.3	2.2	13	ACA sample
Haines	9/17/08	2.1	<1	<20	ACA sample
Whittier	9/11/08	1.2	<1	7.6	ACA sample
Seward	8/15/08	9.5	0.26	6.1	ACA sample
Seward	7/30/08	0.904	1.46	6.91	ACA sample