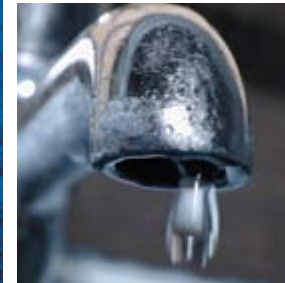


# Case Study

## Sea-water Reverse Osmosis Desalination

P&O Cruises Pacific Sun

December 2004





# Case Study

- P&O Cruises Pacific Sun in dry-dock for major refit
  - Freeport, Bahamas
  
- Required a water supply upgrade
  - Reliable
  - Energy efficient
  - To replace existing evaporator
  
- Turned to H2AU...
  - Who carefully listened to exact needs
  - Designed, built & commissioned P&O's ideal desalination plant
  - Priority project, just a few months to installation deadline
  
- In this case study, discover...
  - Who we are
  - How we helped P&O Cruises
  - Our industry-leading innovations & benefits
  - How we can help you

# How can we help you?

- Desalination for any situation
  - Any size
  - Any time
  - Any place
  - We listen & we care!
- Ship & ocean liner desalination plants
- Land based on-shore systems
- Off-shore platforms & rigs



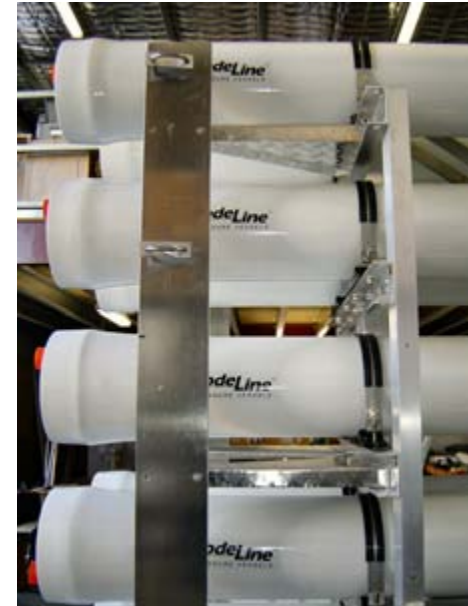
# Who is H2AU?

- **Forward thinking Australian business**
  - Latest desalination technology from around the world
  - Friendly, meaningful relationships with our customers
  - Tailored solutions to your exact needs
  - Continuously improving on best practice
  - Industry leading parts
  - Fast worldwide service & support
  - Quality to be proud of
  - Here for the long term
  
- **10 year's experience**
  - Vacuum distillation
  - Thermal & membrane desalination
  
- **We delight in understanding your exact needs**
  
- **We look forward to answering any questions at all!**
  - Call +61 2 4351 9200 worldwide, or in Australia (02) 4351 9200
  - Email [water@h2au.com](mailto:water@h2au.com)
  - Web [www.h2au.com](http://www.h2au.com)
  
- **Desalination... down-under**



# The benefit of H2AU

- Desalination the way you want it
- Choose from a range of exciting new innovations
  - Custom designed & built, whatever capacity you require
  - Industry leading energy recovery technology cuts your energy costs 60%
  - 2-in-1 redundancy ensures continuous water supply
  - 24/7 PLC automation, safety & diagnosis
  - 2<sup>nd</sup>-pass systems for high purity or boiler-feed water
  - Clean-in-place module, PLC automated flushing
  - Re-mineralisation module for reticulation-friendly pH
- Complete commissioning, quality training
- Consumables & spares always available
- Comprehensive O&M manuals
- Friendly, responsive service & support



# Onboard Pacific Sun

- 2-in-1 redundancy
  - 2 x 225 tonne/day freshwater, typically <300 ppm TDS
- Energy recovery
  - ~3 kWh/tonne, total consumption
- 2nd-pass module for boiler-feed
  - 20 tonne/day high-purity water, typically 1 ppm TDS
  - Uses ~50 tpd of freshwater output, when required
- Clean-in-place (CIP) module
  - Uses only chlorine-free permeate
  - Flushing, cleaning & preserving
  - Membrane-cleaning based on “normalised” data
  - Gentle chemicals and routines for long membrane life
- Re-mineralisation module
  - For reticulation-friendly pH
- Traditional electro-mechanical control, with “fail-safes” & interlocks



# Energy savings

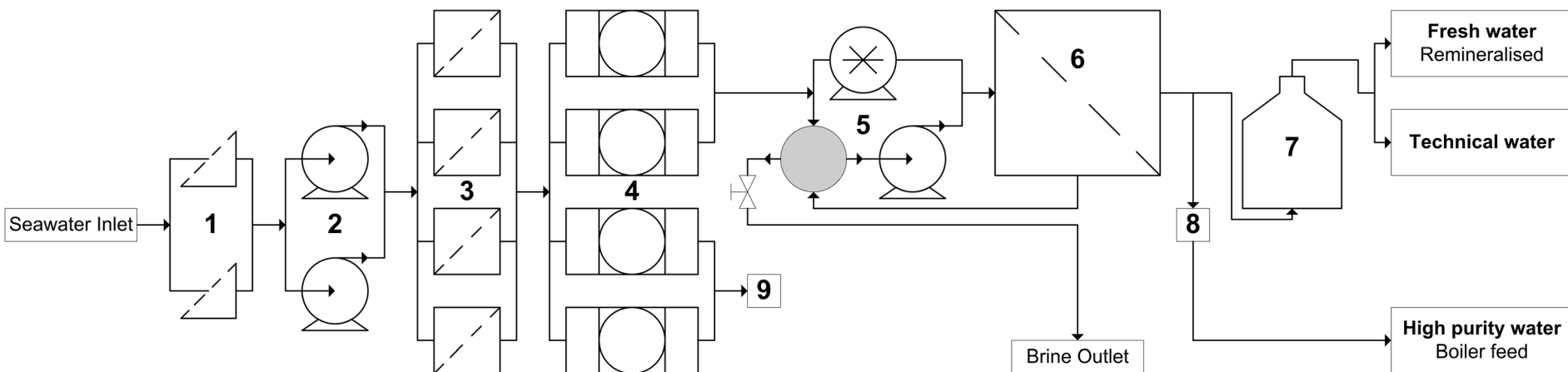
- PX Pressure Exchanger for energy recovery & recycling
  - Takes pressure energy from reject brine
  - Transfers to incoming filtered sea-water
  - Low pressure brine overboard
  
- 1/3 of filtered feed-water to HP pumps & 2/3 of filtered feed-water to PX units
  - So 1/3 of energy requirement is electrical (HP pumps)
  - 2/3 of energy requirement is recovered & recycled (PX units)
  
- Uses ~1/3 energy consumption of conventional RO (without energy recovery)
  - Typically uses ~100 amps – conventional would use >300 amps !
  - $(440 \text{ V} \times 100 \text{ a} \times 0.85 \text{ pf} \times \sqrt{3}) / 1,000 = 64.8 \text{ kW} / 18.8 \text{ tph} = \mathbf{3.4 \text{ kWh/tonne}}$
  
- Energy saving
  - $(\sim 10 - 3.4) = 6.6 \text{ kWh/tonne}$  @ say USD0.15/kWh = USD1 / tonne
  - 450 tonnes/day x USD1 / tonne =
    - USD450                                    saved each day
    - USD13,700                                saved each month
    - **USD164,000**                            **saved each year (24/7)!**
    - USD123,000 p.a.                        saved @ 75% utilisation



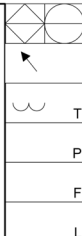
# PX energy recovery system



# Simplified flow diagram



Key	
1	Sea-water debris strainers
2	Feed pumps
3	Bag filtration
4	Cartridge filtration
5	High pressure pumping with PX energy recovery system
6	SWRO membrane array
7	Remineraliser tank
8	2nd pass RO system for high purity water
9	Symmetrical RO trains for 2-in-1 redundancy, same as 5 & 6 above

Electrical System	
Motor Control Centre	
Electronic Automation	
Instruments & Sensors	
Pneumatic Valve Control	

CIP Clean In Place Module
Chemical Mixing Tanks
Strainer
Cartridge Filters
Recirculation Pump
Hook-up Connections

# Major system components

- Pre-treatment
  - 2 raw water strainers: PVC, 1/16" SS baskets
  - 2 feed pumps: single-stage centrifugal, 316L, SiC seals
  - 4 bag filters: gr-polyprop, 10-micron "long-life"
  - 2 x 2 cartridge filters: gr-polyprop, 5-micron polyspun
  
- 2 x membrane filtration plants (ROA & ROB) each with
  - High pressure (HP) pump: swashplate, axial piston, +ve displacement
  - Pressure exchanger (PX): hydrodynamic, ceramic rotor
  - Booster pump for PX units: multi-stage centrifugal, in-line at 1,000 psi
  - Pressure vessels (PVs): fibreglass, 1000 psig rated, ASME
  - Membranes: 8" x 40" spiral-wound, hi-rejection
  - High salinity auto-dump valves (typically set @ 1,000 uS/cm)
  
- Remineralisation/neutralisation
  - Fibreglass upflow contact vessel with calcite chip media for pH adjustment
  
- Freshwater connection for ship's tanks, 4" ABS thermoplastic
- "Technical water" connection, 2" or 3" ABS thermoplastic

# Major system components



# More system components

- 2nd-pass (“baby”) RO plant for 20 tonne/day boiler-feed production, when required
- CIP (clean-in-place) module
  - Caged polyethylene storage tanks, 2 cu m, immersion coil for temperature control
  - Clean/flush pump with 100-mesh SS strainer
  - 2 x gr-polyprop, 5-micron, cartridge filters, wire-reinforced cleaning hoses
- Other
  - HP pipework: sched 40 stainless steel, Victaulic connections, hydrostatically tested
  - LP pipework: ABS engineering thermoplastic
  - skids & frames: marine-grade (ship-builder’s) aluminium
  - instrumentation: temp, flow, press, conductivity, level, pump hours, volts, amps, alarms
  - dry-running protection: all pumps, with indication
  - emergency-stops: with “fail-safe” intake/discharge butterfly valves (air open, spring close)
  - materials: all marine-grade, industry-best components

# More system components



# Budget price

- USD 450,000 C&F (AUD1.00 = USD0.77)
- Including
  - Membranes
  - Initial set of bags & cartridges
  - Calcite media
- Excludes
  - H2AU dry-dock attendance, on-board setup, commissioning, training (next slide)
  - CIP chemicals (shipped with plant if required, est USD3k)
  - Spare parts (shipped with plant if required, est USD22k)
  - Preliminary site visit
- **Timing ... requires prompt decision-making!**
  - Sourcing world's best components, production schedules always tight!
  - Need to book shipping space, Sydney to dry-dock
  - Design issues: which dry-dock? on-board space(s) available? requires site visit



# On-site services

- By H2AU
  - De-stuff container (40' high-cube, need secure w/house)
  - Setup equipment on-board
  - Commission, train, “normalise” membranes (1st voyage)
  - 3 personnel, USD400/day ea + travel/accom (est 2 wks dry-dock + 2 wks at sea)
  
- By others (or by H2AU)
  - Assist de-stuffing, load skids/components on-board (direct yard movements)
  - Disconnect & remove existing desal plant, pumps, piping, electrical etc
  - Prepare site, install bed-plates, surface prep & paint, fasten skids
  - ABS piping between decks, from connection points to ship’s services
  - Walkways, platforms, bracing, earthing studs
  - Instrument air, hot/cold water, 220V workplace GPOs (main feeders by Owner)
  - Install new ship’s side valves (by Owner, LR-approved)
  - Deck penetrations, “save-all” or bunding, hose hooks, work-bench, locker
  - Install lighting as needed, clean site, make-good & paint equipment spaces



# What's next?

- More information?
  - [www.h2au.com](http://www.h2au.com)
- Contact us
  - [water@h2au.com](mailto:water@h2au.com)
  - or **call** +61 2 4351 9200
- We look forward to answering any questions at all
  - We encourage you to contact us as soon as possible.
  - We delight in accurately understanding your needs, up-front!
- Scheduling & timing of projects is critical!
  - Project planning needs to include
    - Sourcing of world's best components
    - Managing production schedules
    - Making a preliminary site visit
    - And so on
- We can provide priority service
  - Prompt decision-making is required!
- Let's get started - contact us today



- To print this case study, click “Print” below
- To exit, click “Exit” below

Remember, we delight in accurately understanding  
your needs... up-front!

So any questions at all please!

Preliminary site visit essential!

"MV Pacific Sun" images courtesy of P&O Cruises.

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