Think Out of the Box: Not All Sea Water Submerged Pump Failures Are Mechanical

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Outline

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- Background
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- Submersible Pump Caisson Designs
- Suction Bearing Designs
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- Failure Mechanism (Sequence of Failure)
- Conclusions
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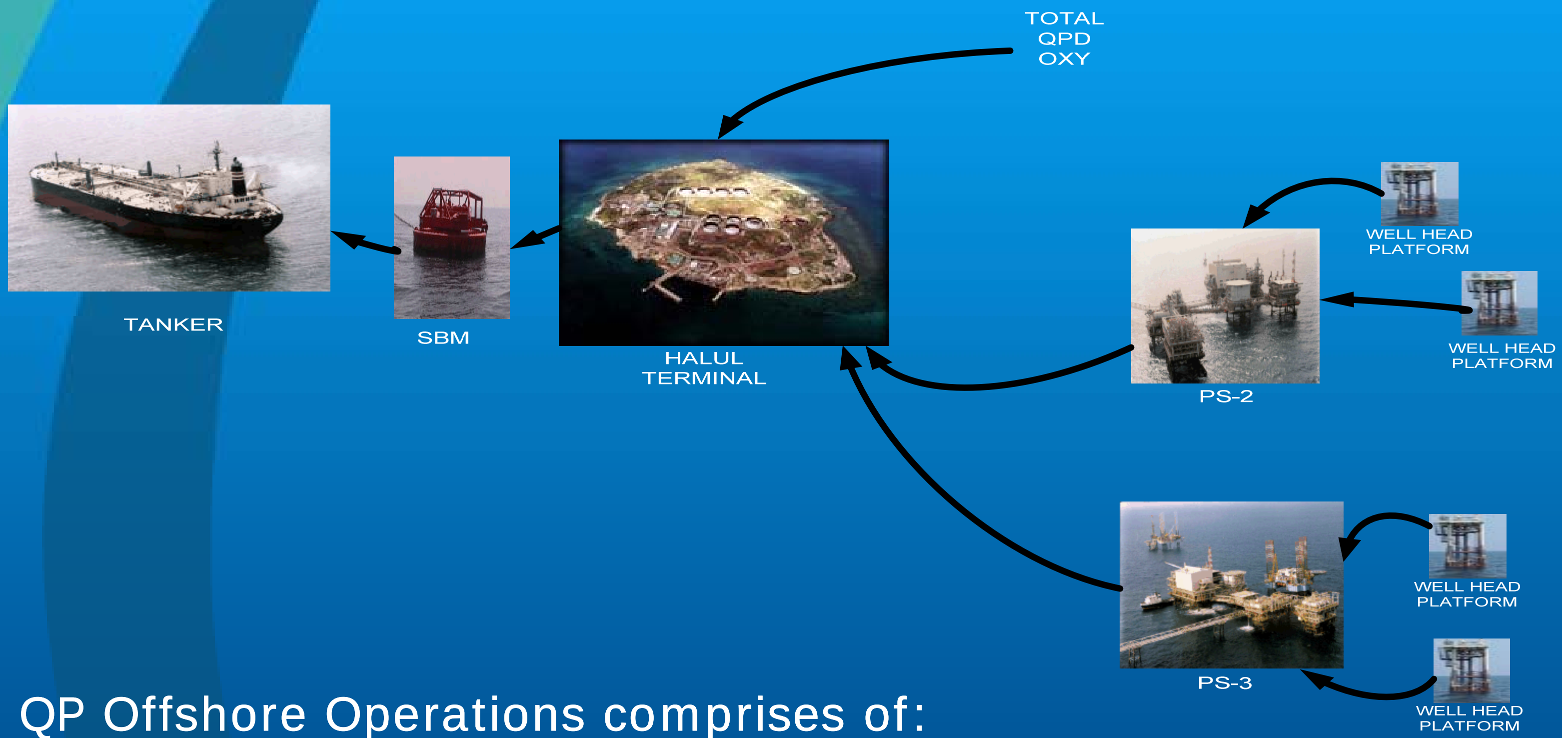
Introduction to QP Offshore



QP Offshore Operations comprises of:

- Halul Storage and Loading Terminal
- 2 Production Platforms:
  - Maydan Mahzam (MM): PS-2
  - Bul Hanine (BH) : PS-3

Backgrounds

- Each Station has vertically suspended submersible pumps:
  - 2 Raw Water Pumps (1 operation / 1 standby)
  - 4 Fire Water Pumps (all standby)
  - 3 Sea Water Pumps (2 operation / 1 standby)
- Raw Water Pumps were replaced in 2003 to accommodate higher water demand.
- All New Raw Water Pumps & some Fire Water Pumps experience frequent failures with common phenomena: blocked/clogged suction strainer with marine growth
- High residual chlorine injection rates (4 times the SCENR requirements).

Failure History

(PS-3 LQ FWP) Suction Bell, Aug 2009

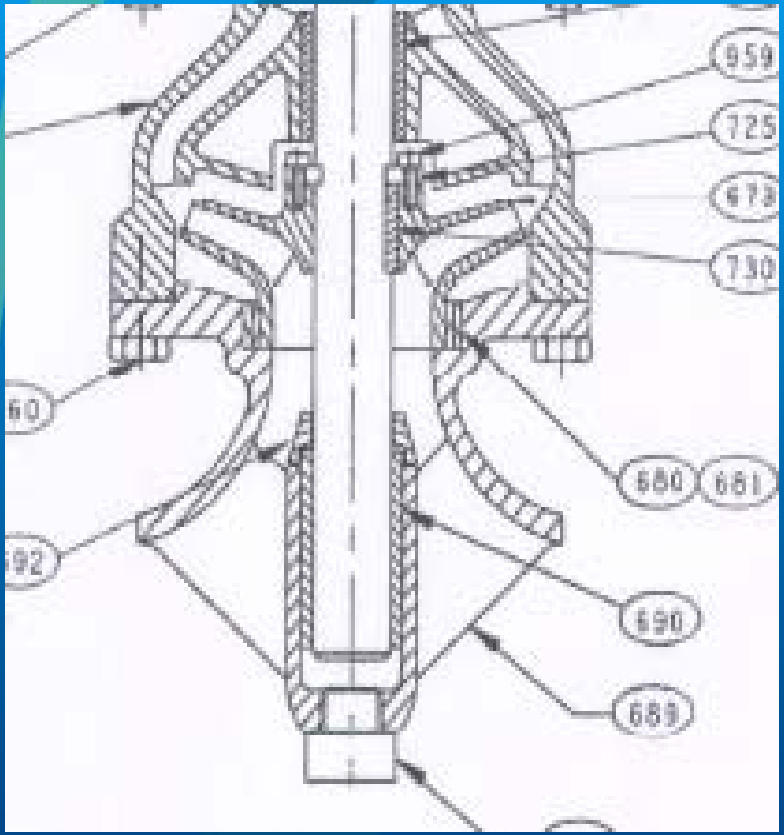
Submersible Pump Caisson Designs

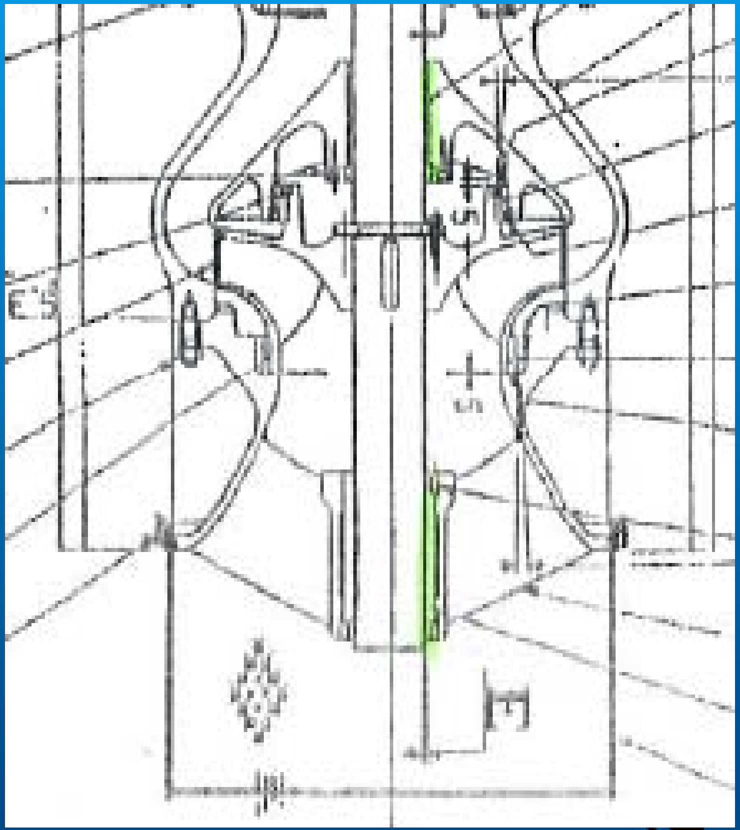
Pump Caisson Designs & Suction Bearing Types in PS-2/3

Pump	Tag No	Caisson Design	Suction Bearing Type
LQ Fire Water Pump	**P-3207 / P-3306**	**5 m longer***	**Bronze (no groove)**
B Fire Water Pump	P-4206B / P-4306B	1.5 m longer	SST (no groove)
G Fire Water Pump	P-4206A/S & P-4306A/S	0.2 m longer	Bronze –Rubber with Groove (Cutlass)
Raw Water Pump	**P-4213A/S & P-4313A/S**	**shorter**	**Bronze (no groove)**
Old Raw Water Pump	P-4213A/S & P-4313A/S	shorter	Bronze –Rubber with Groove (Cutlass)
Sea Water Pump	P-4205A/B/S & P-4305A/B/S	shorter	Bronze –Rubber with Groove (Cutlass)

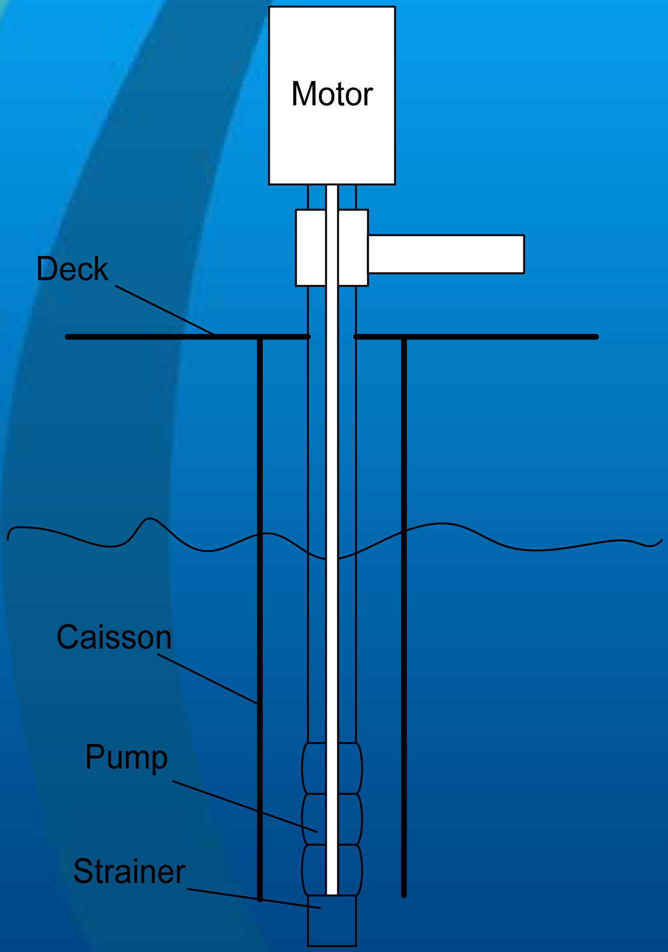
* Modified in July 08 to allow access for cleaning of strainer

Suction Bearing Design

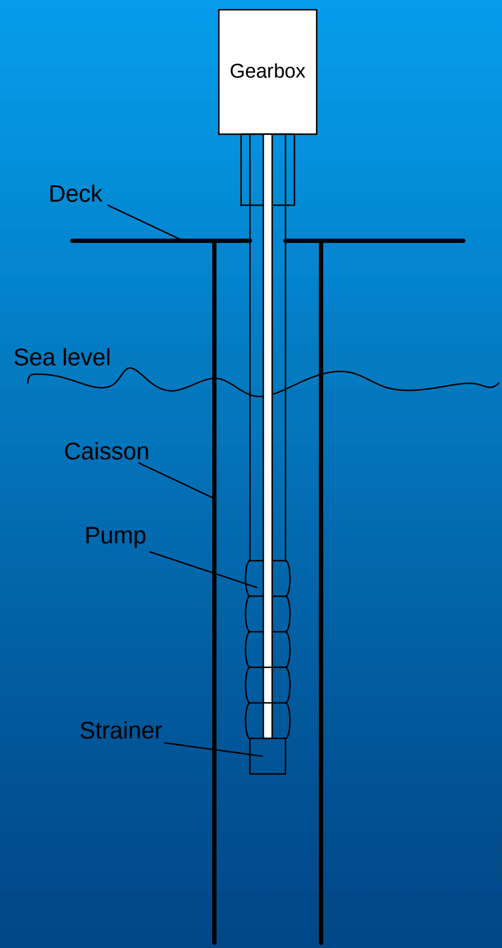




Caisson Designs

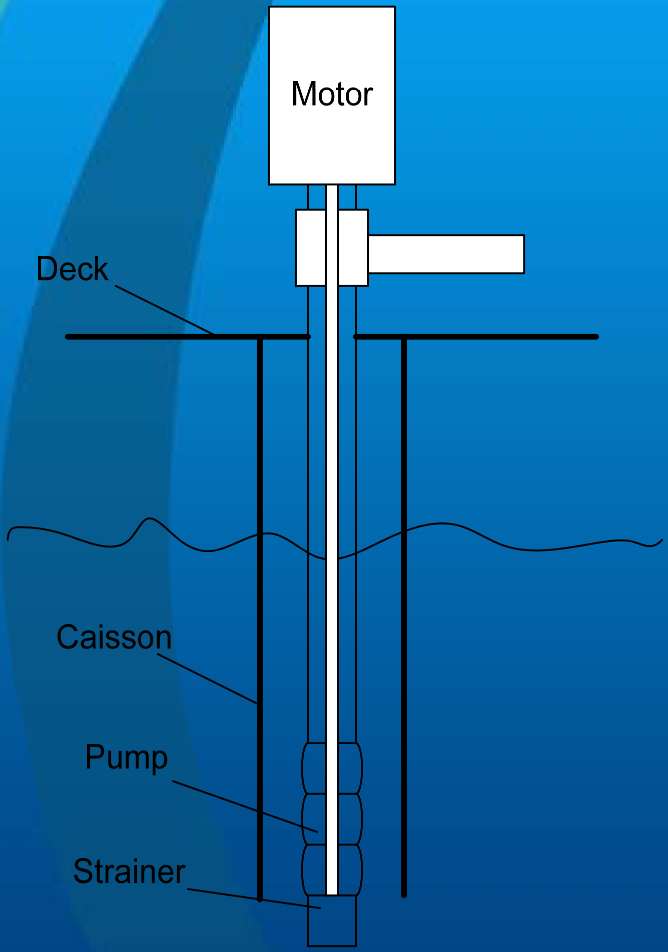


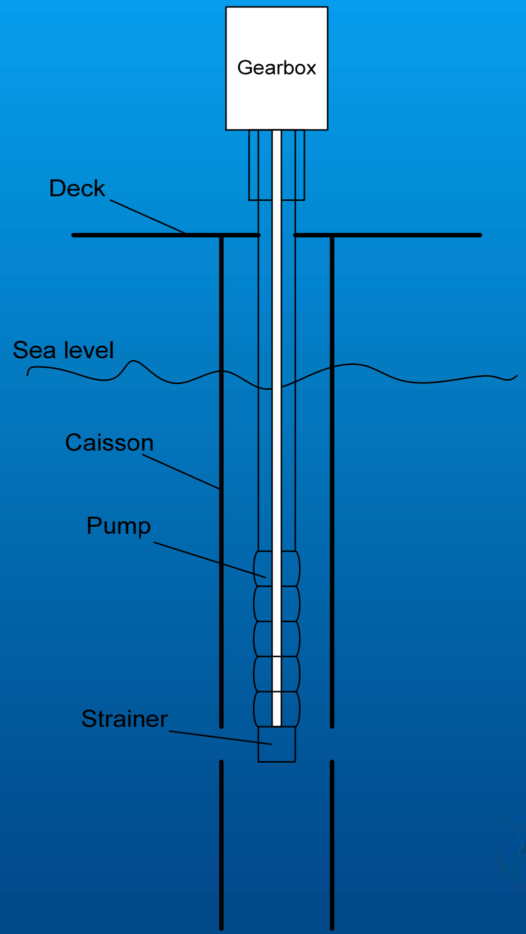
Raw Water Pump (1977)



LQ FWP (2005)

Caisson Designs (continued)

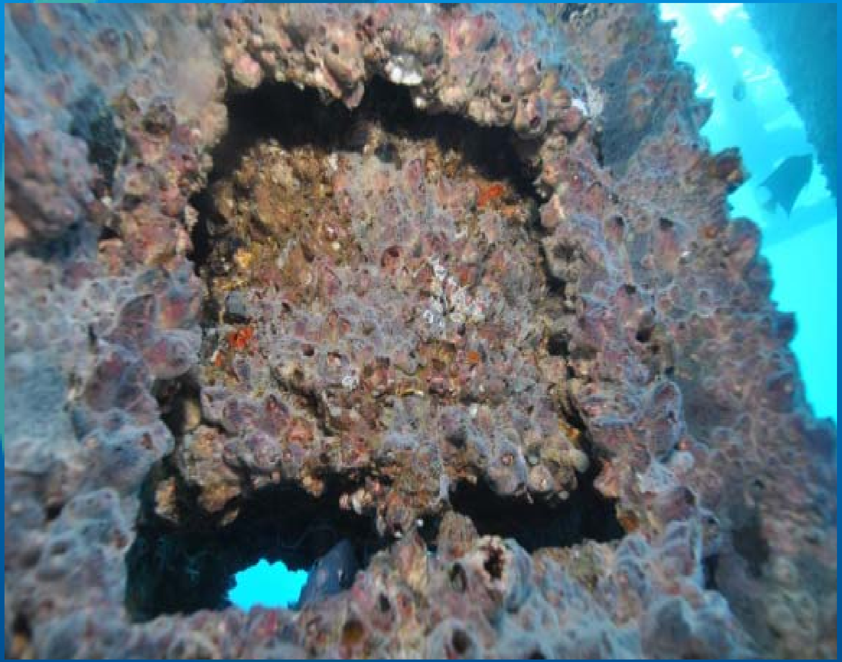




Raw Water Pump (2004)

LQ FWP (July 08)

PS-2 LQ Fire Water Pump Strainer



Experiment Video & Findings

Video

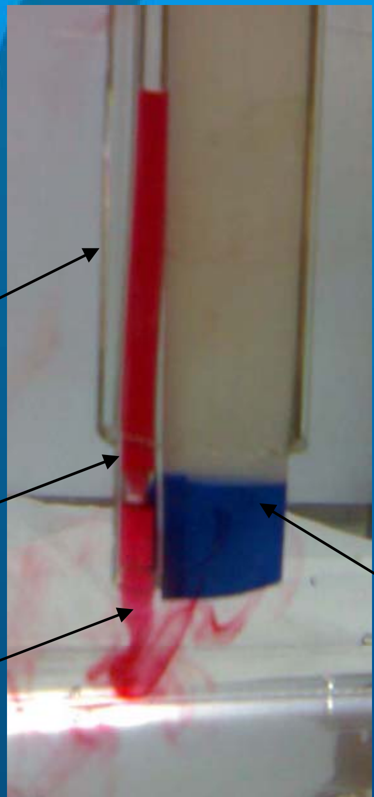
"Strainer Outside the Caisson" Simulations

- Standby Condition
- Operating Condition

"Strainer Inside the Caisson" Simulations

- Standby Condition
- Standby Rough Sea
- Operating Condition

Experiment Findings

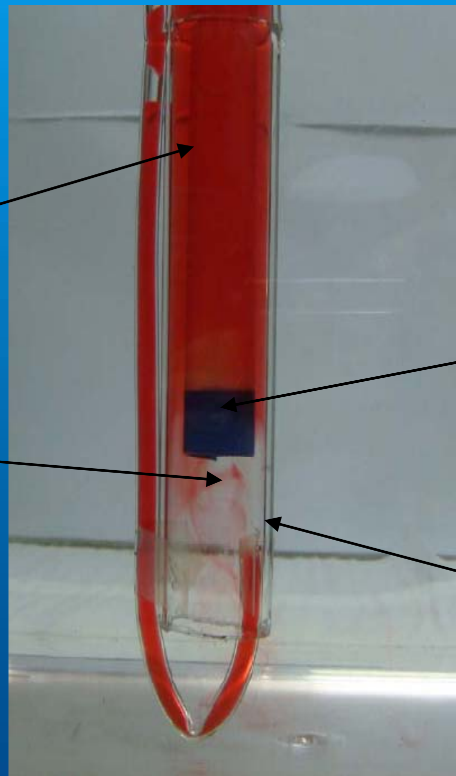


Caisson

Chlorine Injection Line

Chlorine concentration

Pump Suction Strainer



Chlorine Injection Line

Chlorine concentration

Pump Suction Strainer

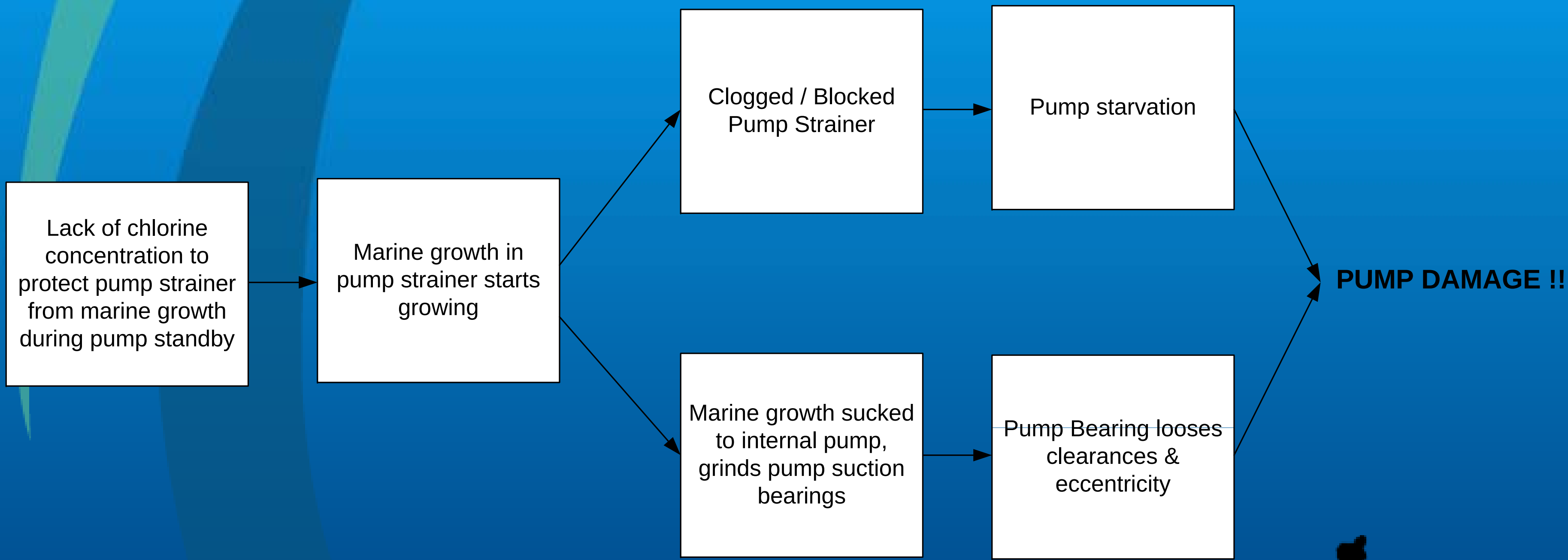
Caisson

Caisson Designs from Other Operators

Companies / Operations	Function	Caisson Length*	Residual Chlorine
BP -ETAP	Sea Water Pump	45 m longer	Injection for 20 min each shift
QP PS-4	Sea Water Pump	6 m longer	0.1 ppm
QP PS-4	Fire Water Pump	5 m longer	0.1 ppm
Total Indonesia	Fire Water Pump	0.9 m longer	Unknown

* Caisson length below pump strainer

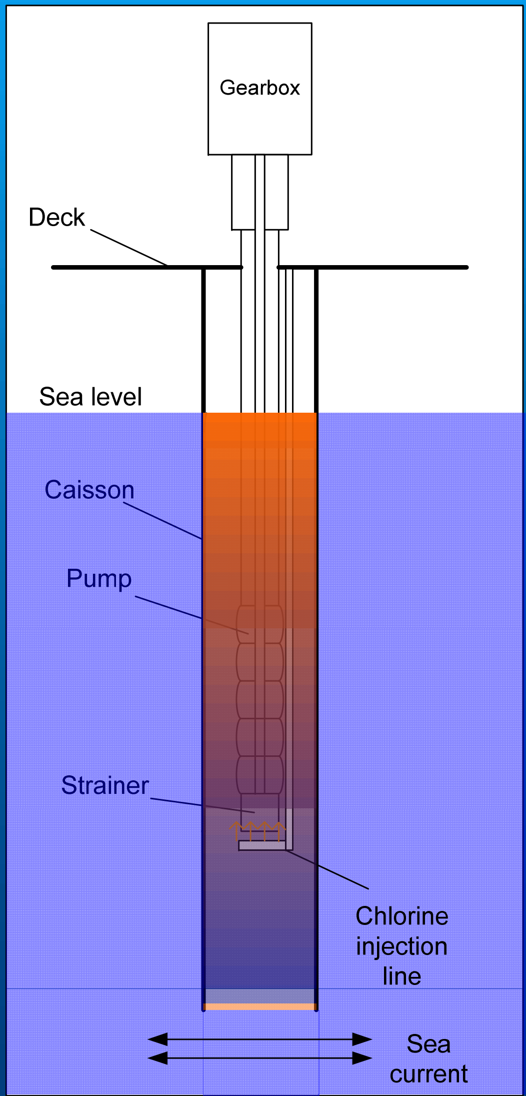
Failure Mechanism (Sequence of Failure)



Conclusions

- ❖ The longer caisson design has the following advantages:
  - Retains chlorine concentration inside the caisson from being washed away by sea current
  - Prevents flying young mussels or barnacles brought by sea current to attach to the strainer body and grow inside it
  - Avoids direct chlorine injection to open sea
  - Protects the pump against force from sea bed
  - Allows our stations to meet MoE (formerly SCENR) requirement for residual chlorine content (0.1 mg / L)
  - Eliminates the need for diving inspection for cleaning the strainer
- ❖ The type of suction bearing has contribution to the pump reliability due to better abrasive resistance capability

Recommended Design



Actions

- Close the windows of LQ FWP caissons to retain original design
- Extending the caisson's length for Raw Water Pumps (P-4213A/S & P-4313A/S)
- Study the replacement of suction bearing type for Raw Water Pumps with bronze - rubber with groove type.