Using Salt Water in Cooling Towers

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Once-through Cooling:
Results Symposium

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Motivation & Increasing Interest

- **Increasing use of non-fresh waters**
- **Retrofit pressures---**
  - **once-through plants on ocean**
  - **U.S. and EU**

Issues to Consider

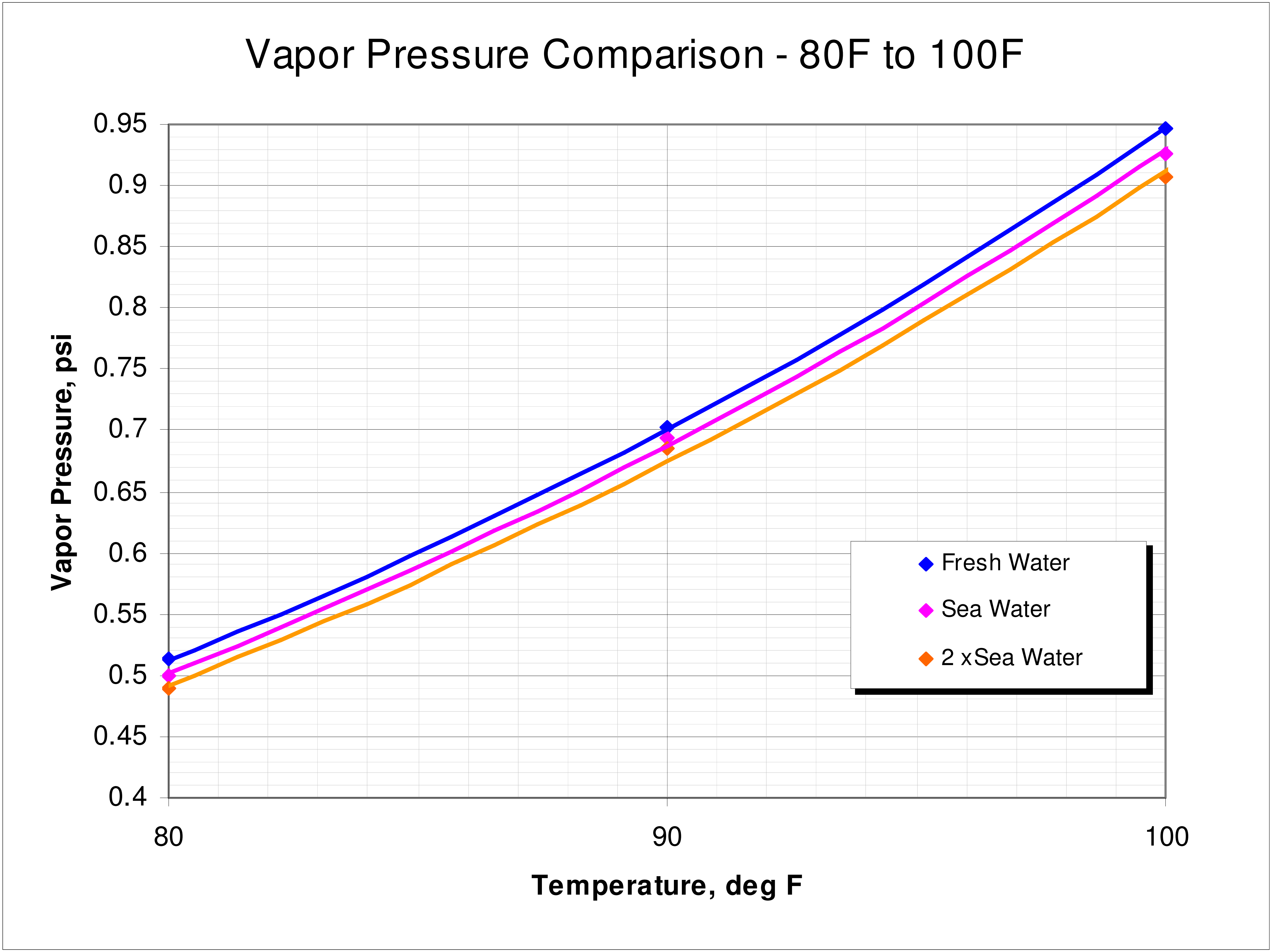
- Experience with salt/brackish towers
- Thermo-physical properties
- Performance
- Cost
- O & M
- Environmental effects

Seawater Towers

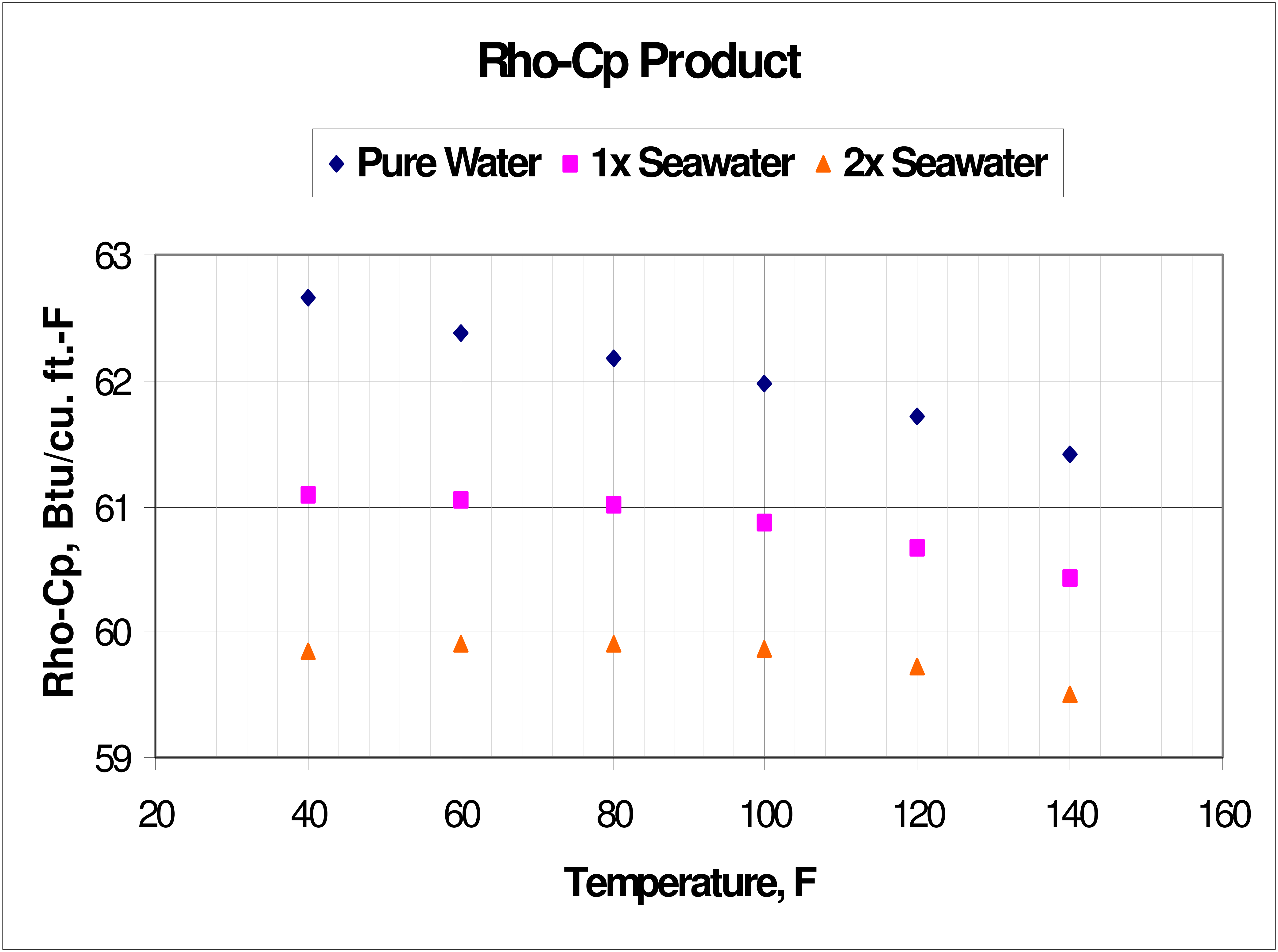
Year	Owner	Site	Flow		Plant Size (@500gpm/MW)
			(m^3/hr)	gpm	MW
1973	Atlantic City Electric Co. (NJ)	Beesley's Point	14,423	63,351	127
1976	Public Service Electric & Gas	Hope Creek	250,760	1,101,431	2,203
1981	Jacksonville Electric Authority	Jacksonville	112,520	494,230	988
1990	Florida Power Corp.	St. Petersburg	156,000	685,210	1,370
1992	Atlantic City Electric Co. (NJ)	B. L. England	16,280	71,508	143
1999	Florida Power Corp.	Crystal River	67,229	295,295	591
2000	St. John's River Power Park	Jacksonville (FL)	56,258	247,106	494

Brackish Water Towers

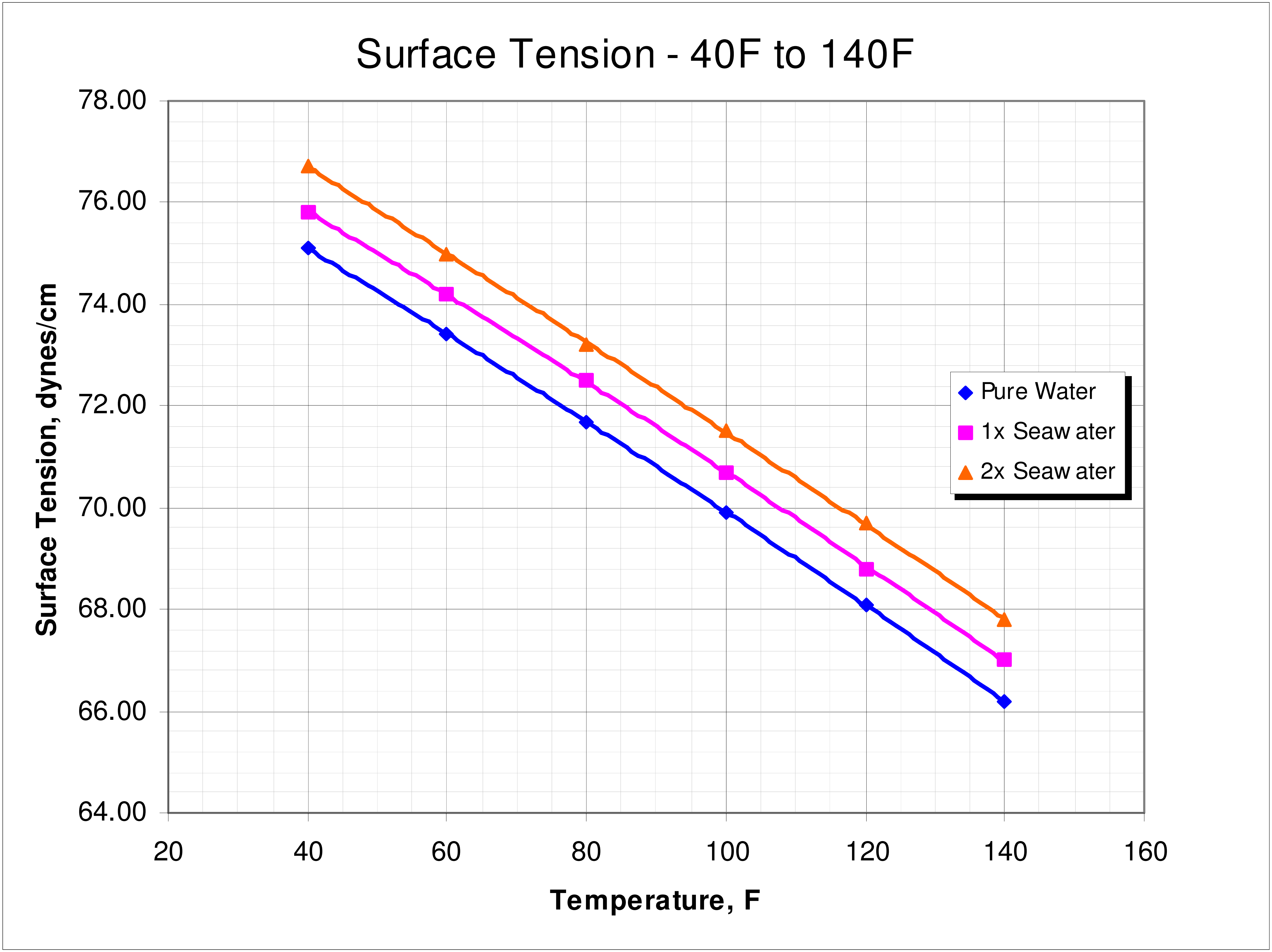
Year	Owner	Site	Flow		Equiv. Plant Size (@ 500gpm/MW)
			(m^3/hr)	gpm	MW
1953	Oklahoma Gas & Electric	Oklahoma	13,680	60,088	120
1964	American Salt Co.	Kansas	1,140	5,007	10
1968	Exxon Chemical	New Jersey	5,016	22,032	44
1971	Gulf Power	Florida	37,620	165,241	330
1973	Dow Chemical	Texas	13,680	60,088	120
1974	Potomac Elctric	Chalk Point 3, MD	59,280	260,380	521
1975	Virginia Electric	Virginia	75,240	330,482	661
1975	Pfizer	North Carolina	12,442	54,650	109
1976	Dow Chemical	California	2,736	12,018	24
1976	Italco Aluminum	Washington	9,348	41,060	82
1976	Pacific Gas & Electric	Pittsburg, CA	84,816	372,543	745
1977	Houston Lighting & Power	Texas	54,720	240,351	481
1980	Mississippi Power	Plant Jackson	39,444	173,253	347
1981	Potomac Electric	Chalk Point 4, MD	59,280	260,380	521
1985	Palo Verde I	Arizona	133,836	587,857	1,176
1986	Palo Verde II	Arizona	133,836	587,857	1,176
1986	Stanton Energy #1	Florida	45,600	200,292	401
1987	Palo Verde III	Arizona	133,836	587,857	1,176
1987	Houston Lighting & Power	Texas	54,948	241,352	483
1989	Delmarva Power & Light	Delaware	46,170	202,796	406
1991	Delano Biomass	California	4,423	19,427	39
1995	Stanton Energy #2	Florida	45,600	200,292	401



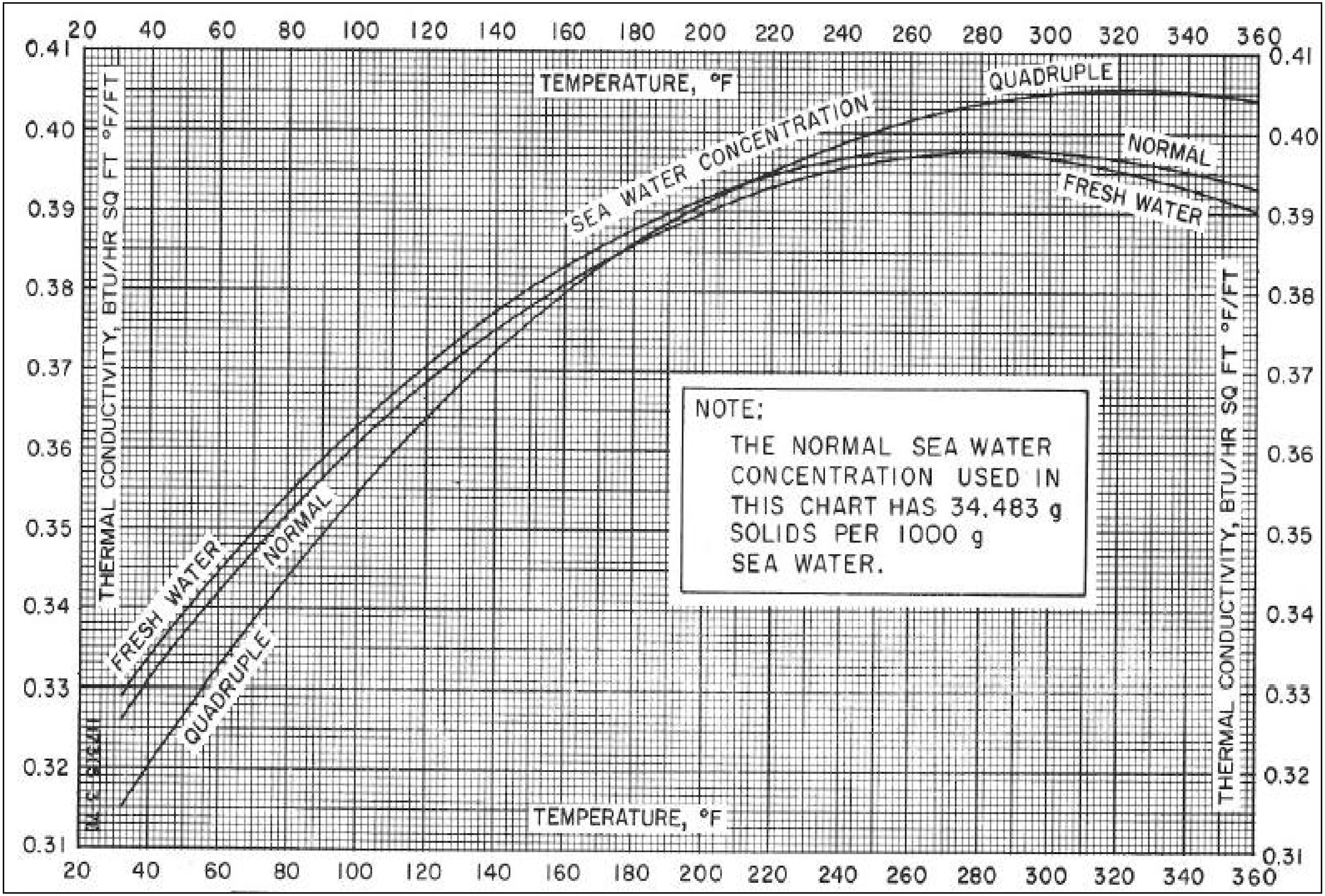
Vapor Pressure Comparison - 80F to 100F
Vapor Pressure, psi
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
80
90
100
Temperature, deg F
Fresh Water
Sea Water
2 xSea Water



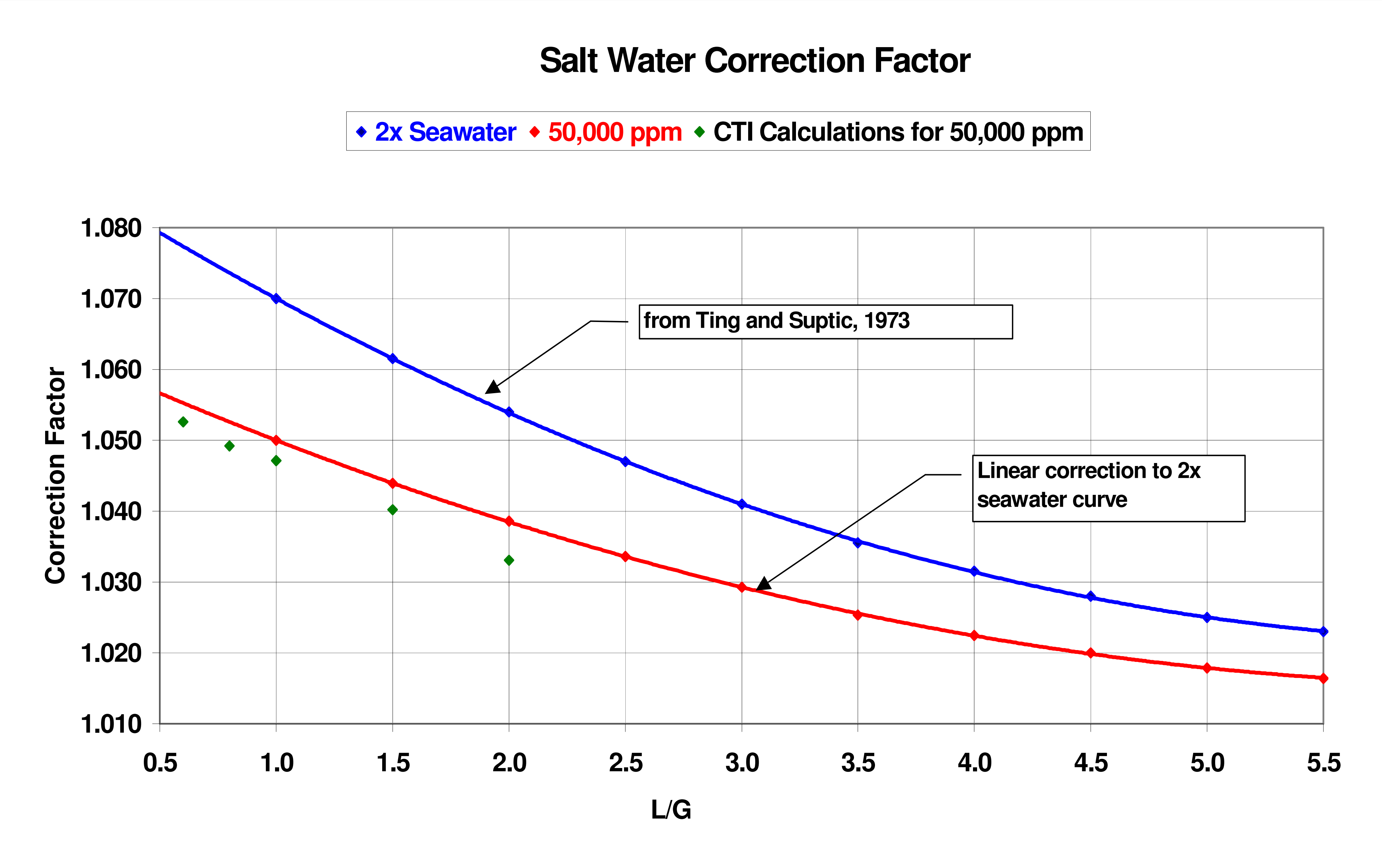
Rho-Cp Product
Pure Water
1x Seawater
2x Seawater
63
62
61
60
59
Rho-Cp, Btu/cu. ft.-F
20
40
60
80
100
120
140
160
Temperature, F


Surface Tension - 40F to 140F
78.00
76.00
74.00
72.00
70.00
68.00
66.00
64.00
Surface Tension, dynes/cm
20
40
60
80
100
120
140
160
Temperature, F
Pure Water
1x Seaw ater
2x Seaw ater

Thermal Conductivity



Performance Corrections



Performance Related Cost Increases

Make-up Water	Low First Cost		Evaluated Cost	
	Cost ($1,000)	Impact (%)	Cost ($1,000)	Impact (%)
Fresh water	1,100	Base	1,400	Base
Brackish (54,000 ppm)	1,149.5	4.5%	1,498	7.0%

Materials Related Cost Increases

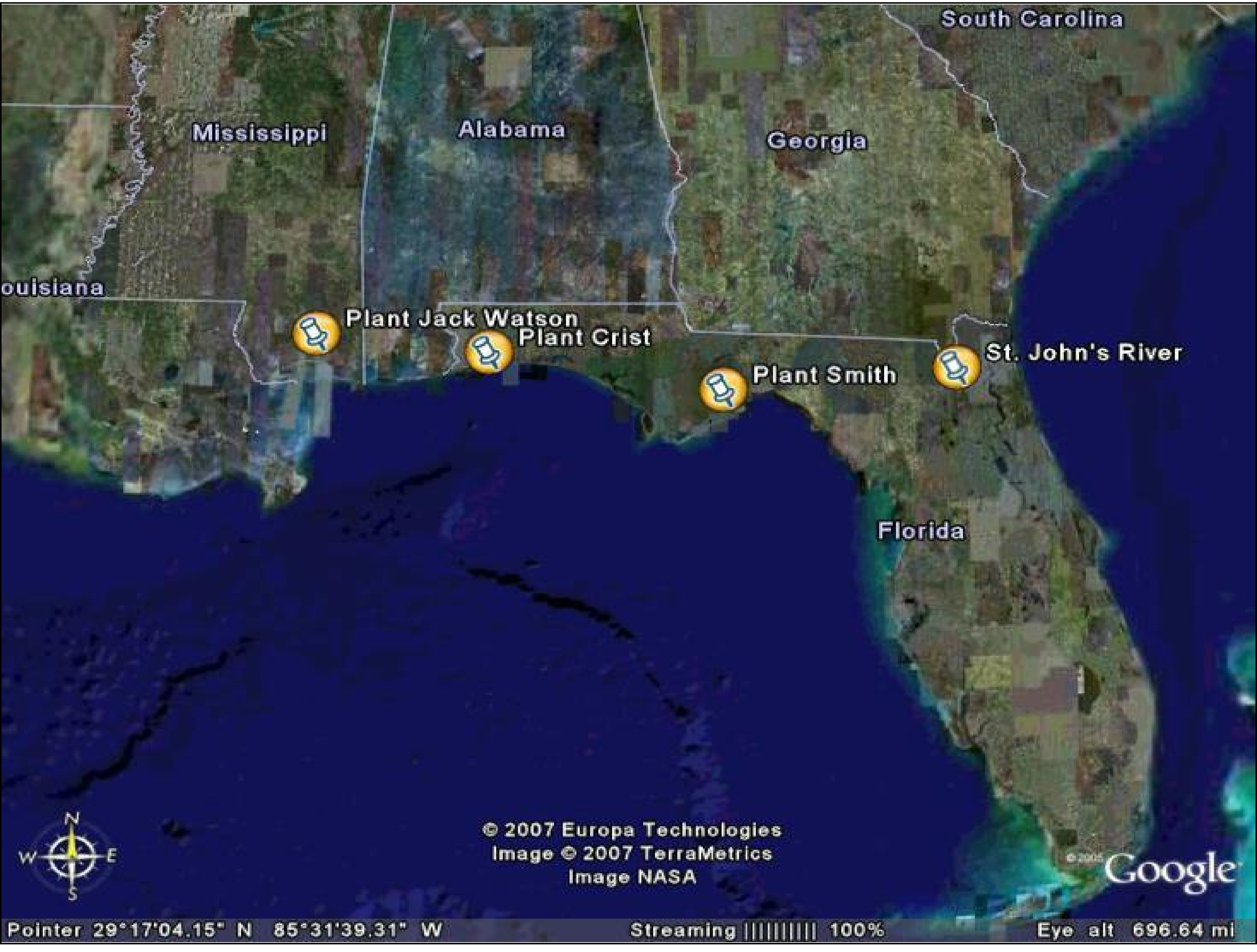
Item	Low First Cost		Evaluated Cost	
	Douglas Fir	FRP	Douglas Fir	FRP
'Base Tower"	1,100	1,287	1,400	1638
Increase for salinity	--	58	--	115
Silicon Bronze fittings	--	112	--	120
Epoxy coatings	--	28	--	30
Total	1,100	1,485		1,903
% increase	--	35%		36%

Other System Components

Item	Fresh water	Salt water	Cost ratio
Cooling tower	$24/TU	$33.6/TU	1.4
Circ. water pump	$130 - $260/BHP	$210 - $416/BHP	1.6
Make-up water pump	$337/BHP	$539/BHP	1.6
Make-up system	$150/gpm	$200/gpm	1.3

Cooling System Component Cost Comparisons (from WGI report)

O&M Issues


South Carolina
Mississippi
Alabama
Georgia
ouisiana
Plant Jack Watson
Plant Crist
Plant Smith
St. John's River
Florida
N
W
E
S
© 2007 Europa Technologies
Image © 2007 TerraMetrics
Image NASA
Google
Pointer 29°17'04.15" N 85°31'39.31" W
Streaming |||||||||| 100%
Eye alt 696.64 mi

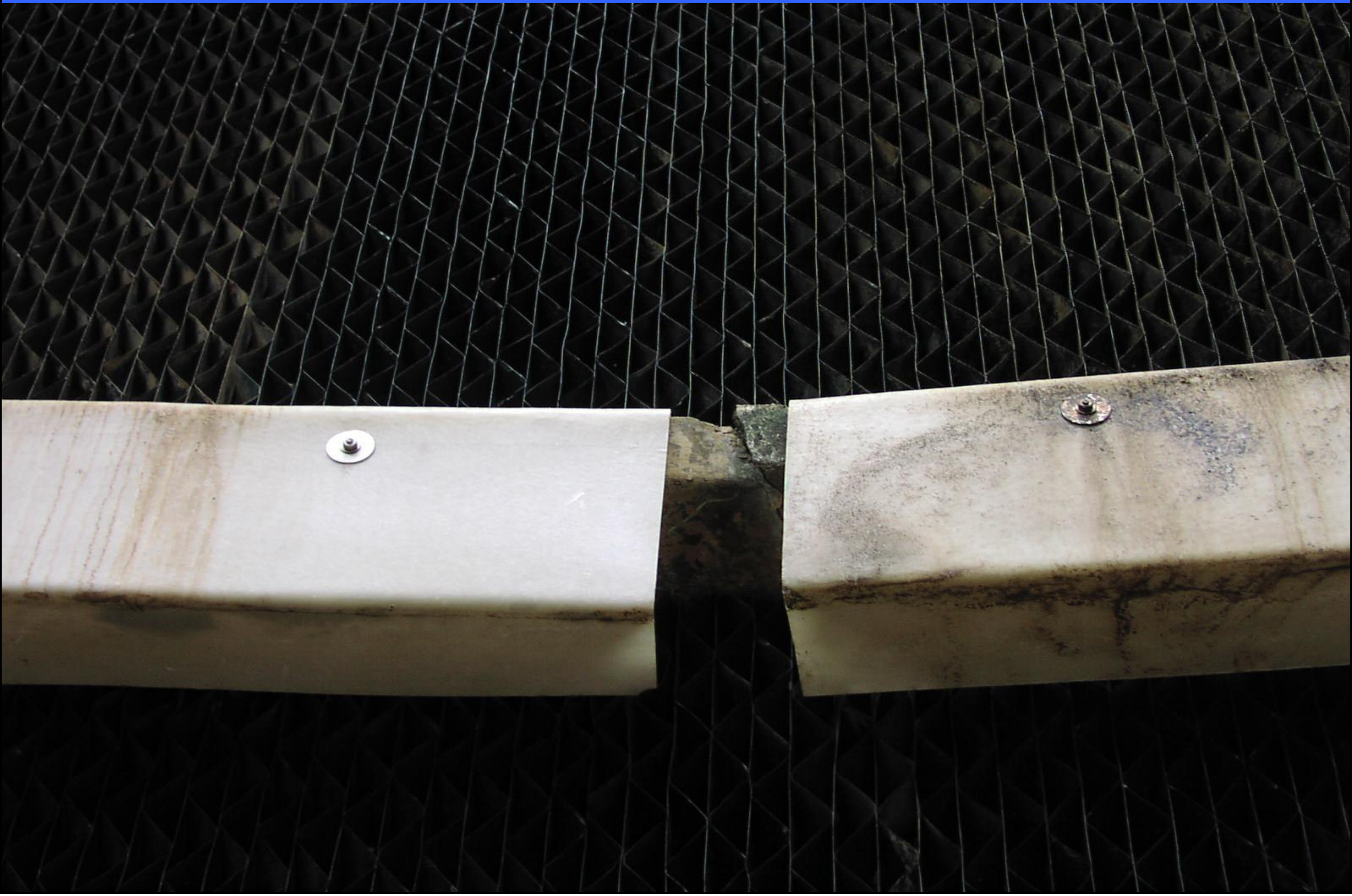
Plant Smith, Unit 3---Fill Support/Structure

Plant Smith, Unit 3---Fill Support/Division Wall

Plant Smith, Unit 3---Fan Deck and Stacks

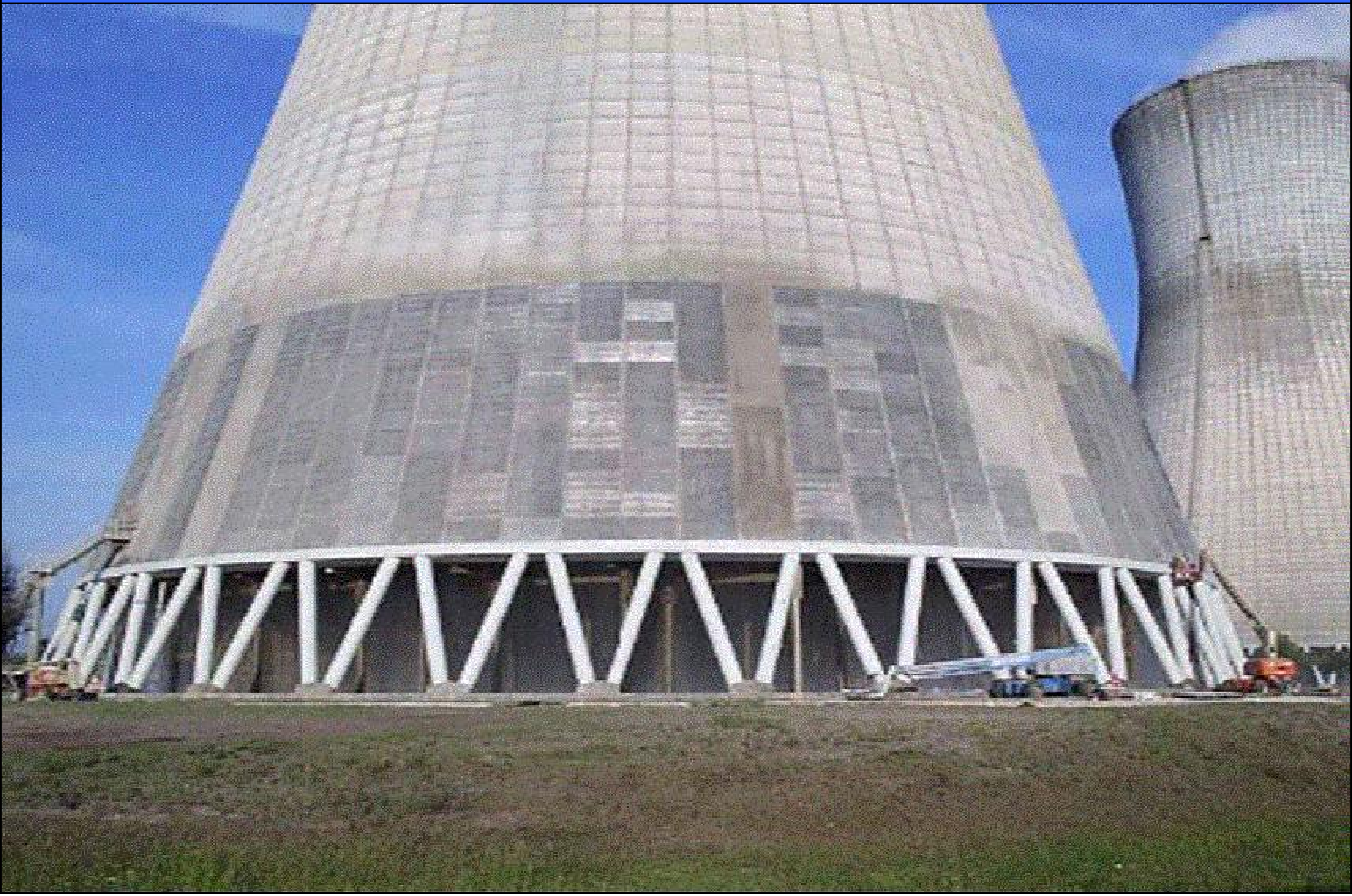
Plant Watson, Unit 5---Failed Fill Supports

Plant Watson, Unit 5---Concrete Damage



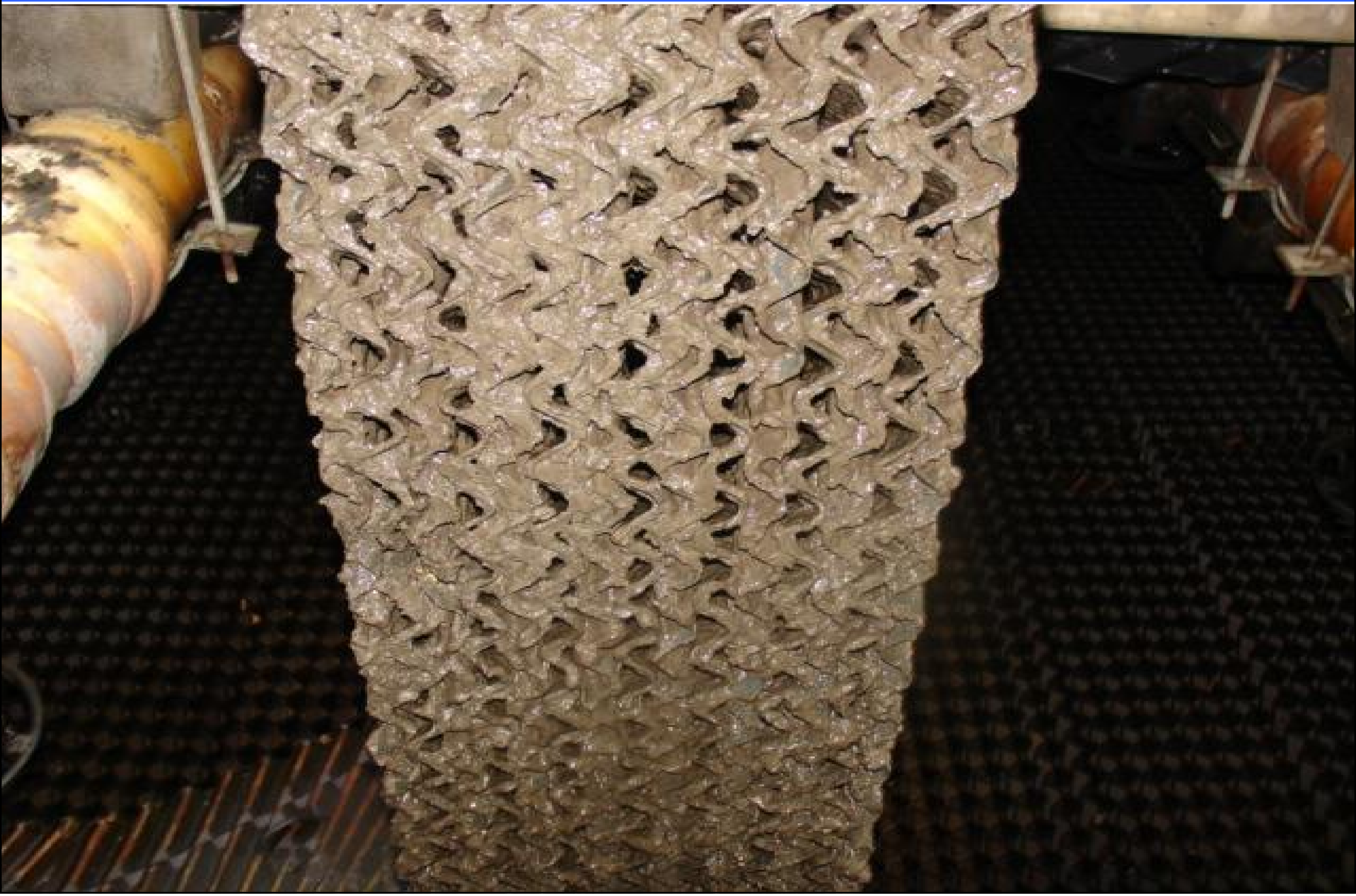
Plant Smith, Unit 3---Basin Concrete Damage

St. Johns River---Real Concrete Damage



St. Johns River---Concrete and Rebar

Watch where the water comes from



Environmental Issues

- Drift
  - PM10
  - Salt deposition
    - on-site
    - off-site
- Discharge of blowdown

Drift---PM10

Assume:

Sea water @ 35,000 ppm

1.5 cycles of concentration

0.0005% drift eliminators

Circ. water flow = 500 gpm/MW

All drift solids are PM10

For a 250 MW steam plant operating 7,500 hr/yr

PM10 emissions are ~ 60 tons per year

Drift---Nearby Corrosion

Drift---Nearby Corrosion

An old environmental study

Conclusions from Environmental Studies

Sources---

- **Chalk Point**
- **St. Johns River Power Park**
- **Marley inquiries---CTI paper**

Consistent Conclusions

- ✓ **Some increased NaCl concentration in deposition samples**
- ✓ **No significant increases in soil or vegetation samples.**
- ✓ **Vegetation off the site with highest deposition was apparently unaffected.**

Summary

- It can be done
- Tower is a little bit bigger and costs a little bit more
- Choose materials wisely
- Be careful with concrete
- Be aware of PM10 issues
- Expect on-site drift-related maintenance issues
- Off-site drift issues probably OK