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The recommendation to relocate the chemical injection points to the wellhead will be pursued.

The water disposal system will be evaluated after the mud plant shut down occurs to determine if the corrosion activity subsides and to determine if corrosion activity is more in line with the well inhibited upstream side. Further recommendations will be based on that evaluation.

Section H.4 Badami

With the shutting in of Badami production for the foreseeable future, monitoring and inspection activity will be limited. However, it is planned to perform a follow-up to the initial shut down inspection in the second half of 2004 to determine if there are any adverse effects from the mothballing. Further recommendations for additional surveys will be made based on that data.

Appendix 1

Glossary of Terms

Glossary of Terms

Term	Definition/Explanation
3 phase production	Unprocessed well head fluids, oil, water, gas – same as OIL
ACT	Alaska Consolidated Team
ATRT	Automated tangential radiographic testing
BAD	Badami
BPXA	BP Exploration (Alaska) Inc.
CCL	Cross country line
CI	Corrosion inhibitor
CIC	Corrosion, Inspection and Chemicals
CIP	Comprehensive Inspection Program
CL	Common line – same as LDF
CMS	Corrosion management system
CPF	Central processing facility
CR	Corrosion rate, mpy
CRA	Corrosion resistant alloy
CRM	Corrosion rate monitoring inspection program
Cross Country lines	Pipelines from the manifold building to major facility
CUI	Corrosion under insulation
CW	Commingled Water
DRT	Digital radiography
END	Endicott
ER	Electrical resistance probe – see corrosion monitoring
ERM	Erosion rate monitoring inspection program
FL	Flow line – same as cross-country
FIP	Frequent inspection program
Frequency C	Continuous
Frequency D	Daily
Frequency H	Hourly
Frequency M	Monthly
Frequency Q	Quarterly
Frequency Y	Yearly/annual
FS	Flow station
G	Gas
GC	Gathering center
GLT	Gas lift transit
GPB	Greater Prudhoe Bay
IIWL	Inter Island Water Line - Endicott
LDF	Large diameter flow line – same as CL
LIS	Lisburne
MFL	Magnetic flux leakage
MI	Miscible injectant
mil	$\frac{1}{1000}$ th of an inch
MIMIR	**M**echanical **I**ntegrity **M**anagement **I**nformation **R**epository BPXA corrosion and inspection database
MPI	Main Production Island - Endicott
mpy	Corrosion rate/degradation rate – mils per year
MPU	Milne Point Unit
MW	Mixed water
NDE/NDT	Non-destructive examination/testing
NIA	Niakuk

Glossary of Terms

Term	Definition/Explanation
NGL	Natural gas liquids
NST	Northstar
OIL	OIL service is 3-phase production service
OWG	Oil, water and gas – 3-phase production
PBU	Prudhoe Bay Unit
PO	Processed oil
ppb	Parts per billion
ppm	Parts per million
PR	Pitting rate, mpy
PTMAC	Point McIntyre
PW	Produced water
RT	Radiographic testing
SDI	Satellite drilling island
Sleeve	Mechanical repair
Slug catcher	First stage pressure vessel of OWG separation facility
STP	Seawater Treatment Plant
SW	Seawater
TRT	Tangential radiographic testing
UT	Ultrasonic testing
VSM	Vertical support member
WAG	Water alternating gas
WL/Well lines	Pipelines from the well head to manifold building
WLC	Weight loss coupon
WPM	Well pad manifold building
WSS	Walking speed survey
WTR	Combined seawater and produced water injection
X-country	Cross country

Appendix 2

Work Plan
Guide for Performance Metric Reporting

2000 Work Plan

Commitment to Corrosion Monitoring

Phillips Alaska, Inc.
BP Exploration (Alaska) Inc.

"BP and Phillips will, in consultation with ADEC, develop a performance management program for the regular review of BP's and Phillips' corrosion monitoring and related practices for non-common carrier North Slope pipelines operated by BP or Phillips. This program will include meet and confer working sessions between BP, Phillips and ADEC, scheduled on average twice per year, reports by BP and Phillips of their current and projected monitoring, maintenance and inspection practices to assess and to remedy potential or actual corrosion and other structural concerns related to these lines, and ongoing consultation with ADEC regarding environmental control technologies and management practices."

Work Plan Purpose:

The purpose of this work plan is to clearly define the purpose, scope, content, reporting requirements, roles and responsibilities, and milestones/timing for the development and implementation of the Corrosion Monitoring Performance Management Program required by Paragraph II.A.6 of the North Slope Charter Agreement.

Corrosion Monitoring Performance Management Program

Purpose: To provide for 'the regular review of BP and PAI's corrosion monitoring and related practices for non-common carrier North Slope pipelines' operated by BP or PAI.

'Corrosion Monitoring' specifically refers to the activity of monitoring pipeline corrosion rates via corrosion probes, corrosion coupons, internal pipeline inspections, and external pipeline inspections.

'Related practices' refers to the assessment of corrosion monitoring data and the associated response to the assessment, specifically chemicals, inspection, and repairs.

Scope: Non-common carrier North Slope pipelines operated by BP or Phillips Alaska, Inc.

"Non-common carrier pipelines" refer to Non-DOT-regulated pipelines. Included in this designation are cross-country and on-pad pipelines in crude, gas, and other hydrocarbon services, as well as, produced water and seawater service pipelines. In module and inter-module on pad piping are not considered part of the scope of this review program.

Content: This Corrosion Monitoring Performance Management Program consists of the following:

1. BP and PAI will "meet and confer" with ADEC twice per year, on average. These sessions will be "working sessions" where BP and PAI will inform ADEC of the following:

   A. Summary description of the inspection and maintenance practices used to assess and to remedy potential or actual corrosion, or other significant structural concerns relating to these lines, which have arisen from actual operating experience. This description will address overall areas of focus, the rationale for this focus, and the nature of monitoring and related practices used during the time since the last meeting. This description may be brief if strategies/focus areas have not changed since the last meeting.

   B. Summary overview of ongoing coupon and probe monitoring results.

   C. Summary overview of chemical optimization activities.

   D. Summary overview of ongoing internal inspection activities.

   E. Summary overview of ongoing external inspection activities.

   F. Summary overview of ongoing structural concerns

   G. Summary of conclusions drawn and responses taken to remedy potential or actual corrosion concerns relating to these lines.

   H. Review/discussion of corrosion or structural related spills and incidents

   I. Review the actions developed by the operator to address any corrosion performance trends that significantly exceed expected parameters.

   J. Summary of program improvements and enhancements, if applicable.

   K. Review of annual monitoring report (see below) at the next scheduled semi-annual meeting.

   The agenda for these meetings will also include an opportunity for open discussion and an opportunity for ADEC to ask questions, provide feedback, etc.

These meetings will be targeted for April and October of each year, although this timing can be adjusted upon the mutual agreement of BP, PAI, and ADEC. The location of the meetings will alternate between the parties.

2. BP and PAI will submit annual reports to ADEC, which will provide the status of current and projected monitoring activities. These reports will be issued on or before March 31st of each year, and reflect the prior calendar year. The following information will be provided:

   A. Annual bullet item reporting the progress of the Charter Agreement corrosion related commitment.

   B. A general overview of the previous year's monitoring activities.

   C. Metrics that depict coupon and probe corrosion rates.

   D. Metrics that characterize chemical optimization activities.

   E. Metrics that depict the number and type of internal/external inspections done, and, as applicable, the corrosion increases/rates and corresponding inspection intervals.

   F. Metrics that characterize the quantity and type of repairs made in response to the internal/external inspections done per the above paragraph.

   G. Metrics that depict the numbers and types of corrosion and structural related spills and incidents.

   H. A forecast of the next year's monitoring activities in terms of focus areas and inspection goals. These forecasts cannot be viewed as binding, as corrosion strategies are dynamic and priorities will change over the course of the year. However, changes in focus will be communicated to ADEC during the semi-annual meetings described above.

   Note: These reports will be presented in, and be part of, a comprehensive North Slope Charter Agreement status report.

3. In addition to the semi-annual "meet and confer" working sessions referenced above, BP and PAI will remain accessible to provide "ongoing consultation" to ADEC regarding environmental control technologies and management practices

   'Environmental Control Technologies' refer to those technologies specifically related to corrosion monitoring and mitigation of the subject pipelines.

   'Management practices' refer to corrosion monitoring and related practices as defined above.

4. During the semi-annual 'Meet and Confer' working meetings with BP and/or PAI, ADEC may use the services of a corrosion expert(s) (contracted from funds under Charter Commitment paragraph II.A.7) to assist in the review of performance trends and corrosion program features.

5. BP has assigned CIC Manager, R. Woollam/564-4437, and Phillips has assigned Kuparuk Engineering and Corrosion Supervisor M. Cherry and J. Huber/659-7384, to be the contacts responsible for ensuring these commitments are met, including ADEC notification of scheduled times for the semiannual presentations. The ADEC contact for this effort is (Pipeline Integrity Section Manager/S. Colberg/269-3078) who will notify interested personnel of the presentation times, maintain the reports for distribution to the public when requested and coordinate other issues relating to this commitment.

Annual Timetable

March 31st	Annual Report
April 30th	1H Semi-Annual Review (Meet and Confer)
October 31st	2H Semi-Annual Review (Meet and Confer)

Guide for Performance Metric Reporting

General

- Different metrics show and reveal different aspects of the business and as a consequence there are rarely any 'right' or 'wrong' measures only 'right' or 'wrong' application and usage
- Summary statistics described below may be provided as a data appendix to the annual reports with the more pertinent tables and graphics being contained in the text as appropriate. The intent is not to clutter and interrupt the flow of the text with extraneous data
- Format of data, the order in which it is presented, etc. of each company's annual report may differ from the order presented below, depending on key messages and data context. For example, one company may choose to imbed Leak/Save data into an inspection graph as opposed to presenting the Leak/Save data in standalone tabular format.
- This is an initial document for implementation in the 2001 annual report to ADEC, it should be noted, that the guidelines provided below can and will be adjusted to improve the efficacy of the annual report and reporting mechanism

Timescale

- Data to be presented on an aggregate annualized basis
- Base year 1995 providing 5 year history before the start of the Charter Agreement and each year's annual report will add to time series starting in 1995

Equipment Classification

- **Well Line** Pipe work from the well head to the Well Pad Manifold Building, generally, the flow from a single well prior to commingling before transportation to the separation plant
- **Flow Line** Pipe work from the Well Pad Manifold Building to the Separation plant, generally, cross country and off pad pipe work which carries commingled flow to/from a well pad. Also, straight run flow from the wellhead to separation plant, without commingling, is classified at Flow Line pipe work
- **Exceptions** Pipe work not conforming to these basic definitions will be reported by exception

Service Definitions

- **Three Phase Production (3ø or OWG)** Basic reservoir fluids (O/W/G – oil, water and gas) produced from down hole through to the main separation plants that typically see only see changes in temperature and pressure from reservoir conditions and are therefore essentially un-separated
- **Seawater (SW)** Water sourced typically from the Beaufort Sea that has undergone primary treatment at the Seawater Treatment Plant. Note, that the seawater treatment plants differ across the slope in the primary treatment methods, most importantly oxygen removal, with both production gas and vacuum stripping being employed
- **Produced Water (PW)** The water produced with the primary reservoir 3 phase production after passing through the separation and treatment
- **Commingled Water (CW) or Mixed Water (MW)** Water which has been commingled and is therefore multi-sourced, this is typically a mix of SW and PW although other combinations exist in the operations on the North Slope
- **Gas (G)** Generic term for a number of different gas systems which transport essentially dry gas between facilities including fuel gas, lift gas and miscible injectant
- **Processed Oil (PO)** The oil/hydrocarbon produced with the primary reservoir 3 phase production after separation and treatment, this is primarily black oil but could include black oil plus NGL's

Basic Summary Statistics

- **Distribution** The data is fundamentally of log-normal distribution, with a lower limit of zero or no-change and potentially unlimited upper extent
- **Count** A count of the number of activities completed i.e. coupons pulled in a given year
- **Average** The average or mean for the criteria being summarized i.e. average corrosion rate
- **Target Value** The target value against which non-conformance, see below, is reported
- **Number Non-conformant** The number of items not conforming to the control criteria i.e. the number of coupons exceeding the control value
- **Percentage Non-conformance** The percentage not conforming to the control value as a percentage of the total

Weight Loss Coupon Data

Table below summarizes the reporting of weight loss coupon data for the major fields on the North Slope

	Well Lines	CCL/FL
3 ø Production	All	All
Seawater	GPB	All
Prod. Water	GPB	GPB
Commingled Water	All	All

The data sets to be provided for both general corrosion rates and pitting rates are,

- Count of coupons
- Average corrosion rate
- Number non-conformant
- % Conformant i.e. 1 minus the % non-conformant

A corrective action list for non-conformant flow lines (FL/LDF/CCL/CLs) will also be provided.

Internal Inspection Data

Table below summarizes the reporting of internal corrosion inspection data for the major fields on the North Slope

	Well Lines	CCL/FL
3 ø Production	All	All
Commingled Water	All	All

Note that no distinction will be made between water services across the North Slope since in many cases the service is variable making meaningful analysis and aggregation difficult.

- The data sets to be provided for internal inspection are,
- Count of inspections
- Number of increases on repeat inspection locations
- Percentage of increases on repeat inspections

A corrective action list for flow lines (FL/LDF/CCL/CLs) with inspection increases will also be provided.

Corrosion Inhibition

The corrosion inhibition program is to be reported as the target and actual total annual gallons and gallons per day, and as concentration, ppm, based on a field wide average.

External Corrosion Inspection

External corrosion inspection program is to be reported as an aggregate of all piping systems without distinction or differentiation of service and equipment type with a summary of the overall program status.

The data sets to be provided for external inspection are,

- Count of inspected location
- Number of corroded locations
- Percentage of inspection locations corroded

Repair and Leak Statistics

The repair and leak/spill statistics to be reported for each year plus the historical trend back to 1995 consistent with other performance metrics. The basic definitions,

Leak/Spill An agency reportable leak/spill for the pipelines covered under the Charter Agreement which was caused by corrosion and/or erosion

Save A location which required repair action as a result of corrosion and/or erosion damage but which was found through inspection prior to causing a leak/spill

The data sets to be provided for Repair/Leak statistics,

- Count of Leaks/Save by flow line and well lines
- Summary of leak/spill causes

Below Grade Piping

The data sets to be provided for Below Grade Piping (BGP) program,

- Number of segments/crossings inspected broken out by inspection method
- Number with anomalies and severity of anomaly

Results of casing digs, visual casing inspections and casing clean-out to be reported as appropriate.

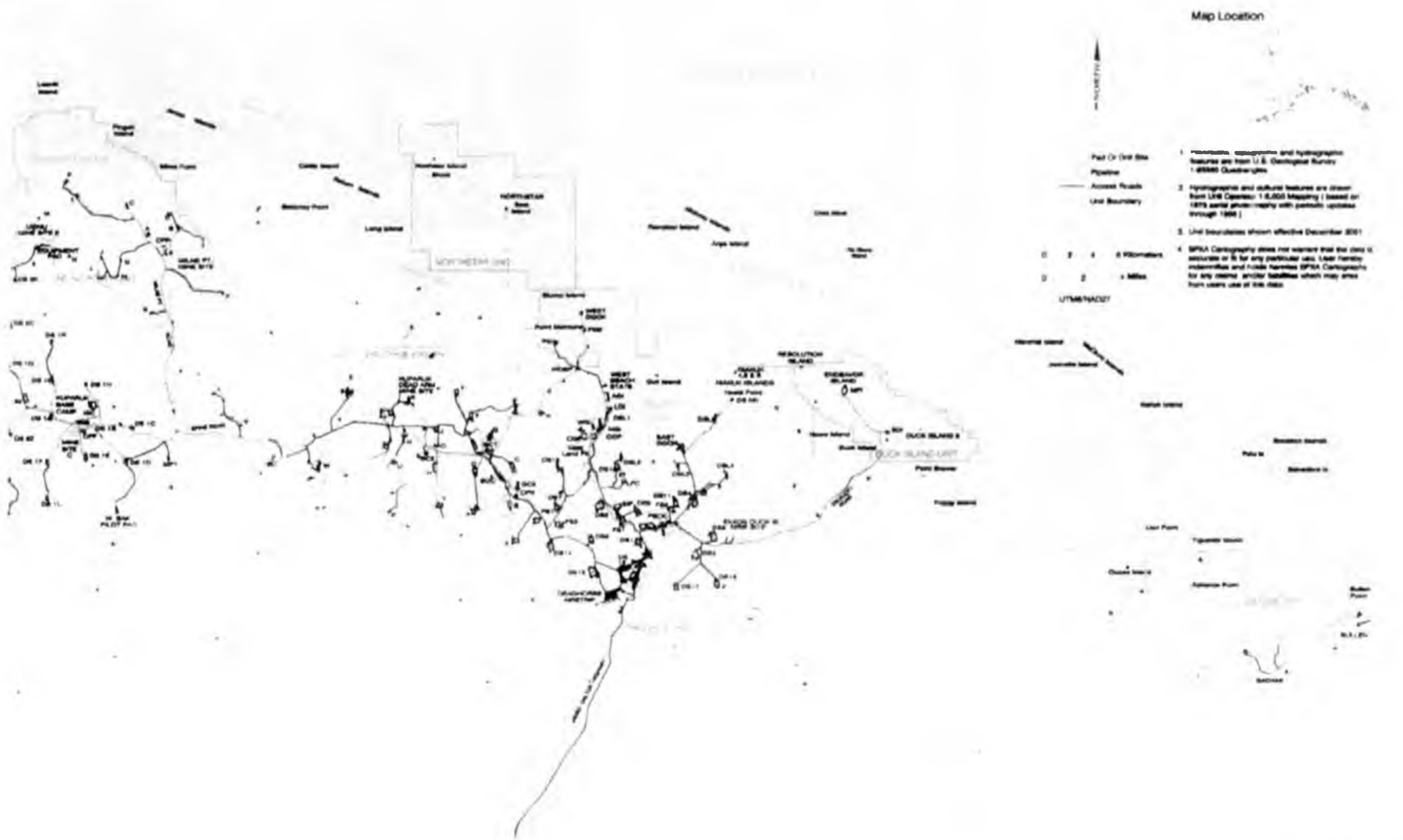
Other Programs

Reporting of ER probe, smart pigging, maintenance pigging, structural issues, and details of individual spill incidents to be reported as dictated by the current year's program activity.

Appendix 3

(a) Map of the North Slope
(b) North Slope Oil Field Facility and Piping Summary

BPXA OPERATING UNITS - NORTH SLOPE, ALASKA



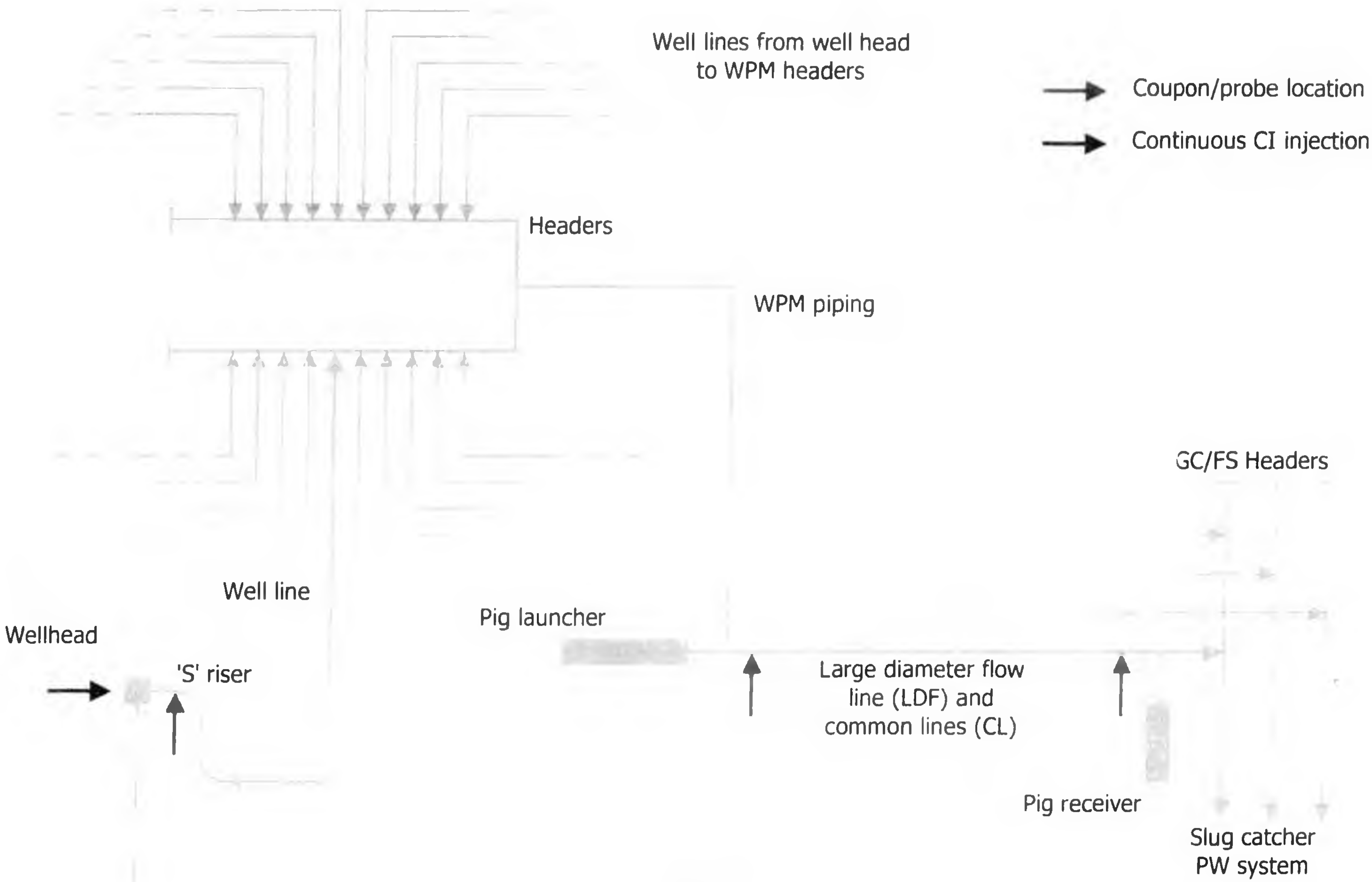
BP North Slope Operations	**Field Data (current 1/01)**	
Greater Prudhoe Bay	Field Area	150,000 acres
	Original Oil in Place (Gross)	25 billion barrels
	Original Gas in Place (Gross)	47 trillion Std. Cu Ft
	Oil Production Wells	1,080
	Gas Injection Wells	36
	Water Injection Wells	174
	Major Separation Plants	6
	Major Gas Handling Plants	2
	Major Water Handling Plants	3
	Miles of Pipelines (approximate)	1,300
Midnight Sun	Field Area	3,000 acres
	Original Oil in Place (Gross)	0.06 billion barrels
	Original Gas in Place (Gross)	trillion Std Cu Ft
	Oil Production Wells	2
	Water Injection Wells	1
	Miles of Pipelines (approximate)	4
Aurora	Field Area	10,000 acres
	Original Oil in Place (Gross)	billion barrels
	Original Gas in Place (Gross)	trillion Std Cu Ft
	Oil Production Wells	5
	Miles of Pipelines (approximate)	1
Pt. McIntyre	Field Area	8,000 acres
	Original Oil in Place (Gross)	0.8 billion barrels
	Original Gas in Place (Gross)	0.9 trillion Std Cu Ft
	Oil Production Wells	59
	Gas Injection Wells	1
	Water Injection Wells	15
	Miles of Pipelines (approximate)	6
Lisburne	Field Area	30,000 acres
	Original Oil in Place (Gross)	1.8 billion barrels
	Original Gas in Place (Gross)	trillion Std Cu Ft
	Oil Production Wells	74
	Gas Injection Wells	4
	Major Separation Plants	1
	Miles of Pipelines (approximate)	27
Niakuk & Western Niakuk	Field Area	1,900 acres
	Original Oil in Place (Gross)	billion barrels
	Original Gas in Place (Gross)	trillion Std Cu Ft
	Oil Production Wells	18
	Water Injection Wells	7
	Miles of Pipelines (approximate)	6

BP North Slope Operations	**Field Data (current 1/01)**	
Milne Point	Field Area	36,454 acres
	Original Oil in Place (Gross)	0.92 billion barrels
	Oil Production Wells	107
	Gas/Water Injection Wells	59
	Source Water Wells	8
	Major Separation Plants	1
	Miles of Pipelines (approximate)	55
Schrader Bluff	Field Area	28,000 acres
	Original Oil in Place (Gross)	1.97 billion barrels
	Oil Production Wells	49
	Gas\Water Injection Wells	14
	Source Water Wells	3
	Miles of Pipelines (approximate)	15
Eider	Field Area	300 acres
	Original Oil in Place (Gross)	0.013 billion barrels
	Original Gas in Place (Gross)	0.052 trillion Std Cu Ft
	Oil Production Wells	1
	Gas Injection Wells	1
	Miles of Pipelines (approximate)	.5
Endicott	Field Area	8,800 acres
	Original Oil in Place (Gross)	billion barrels
	Original Gas in Place (Gross)	1.4 trillion Std Cu Ft
	Oil Production Wells	47
	Gas Injection Wells	5
	Water Injection Wells	21
	Major Separation Plants	1
	Miles of Pipelines (approximate)	52
Sag Delta North	Field Area	380 acres
	Original Oil in Place (Gross)	0.014 billion barrels
	Oil Production Wells	2
	Gas Injection Wells	2
	Miles of Pipelines (approximate)	.5
Badami	Original Oil in Place (Gross)	0.160 billion barrels
	Oil Production Wells	6
	Gas Injection Wells	2
	Major Separation Plants	1
	Miles of Pipelines (approximate)	50
Northstar (current 3/02)	Field Area	38,000 acres
	Original Oil in Place (Gross)	.176 billion barrels
	Oil Production Wells	4
	Disposal Injection Wells	1
	Gas Injection Wells	2
	Major Separation Plants	1
	Miles of Pipelines (approximate)	30

Appendix 4

Facilities Schematic

Facility Schematic



Appendix 5

Data Tables

Introduction

With the introduction of single-operatorship at Greater Prudhoe Bay one of the major problems faced by the Corrosion Inspection and Chemical (CIC) Group was the integration of two historical data sets for inspection, corrosion monitoring and corrosion mitigation information.

There has been a significant investment in resources in order to bring together these two different histories from incompatible databases based on early 1990's technology.

As of the end of 2002, the inspection program and corrosion-monitoring program have largely been integrated into a single database on an Oracle platform with a user interface in VisualBasic.

The database development effort has involved a dedicated team of software developers and database administration but also significant resources from within the CIC Group. The program is currently a "work in progress" and in 2003 BP/CIC will continue work on the development of chemical management, electronic data recording, tank and vessel, and standard reporting modules.

The data is continuously monitored for integrity, quality and consistency; as a consequence any errors detected are corrected as they are found. In addition, as better analysis tools become available through further integration then records are amended to reflect the improved level of analysis.

As a result of the ongoing quality effort and the tracking of production/service changes, this is a 'live' database and therefore as the system changes then the records returned will change. The following are some of reasons why returned values change through time,

Quality Control and Audit A fundamental design philosophy for the database was that errors should be corrected through time as they are discovered. Therefore as the database is used and the quality control rules and procedures applied, data-entry, translation and record-keeping errors are eliminated.

Equipment Service Changes The database tracks active, in or out-of-use equipment, and equipment service changes. As a piece of equipment moves through different services and different status, then the data in the database tracks the equipment status.

Transition Issues As noted above, the two historical databases, heritage East and heritage West, were incompatible with very different structures and data fields. Therefore these have had to be translated to the new system. As the quality control and audit tools are applied to the translated data, error and mistranslations are removed.

Time The database is in active use with data being added everyday, given that there is sometimes a time delay between the reporting date and entry date then the data totals can and do change.

BU	Equip	Service	Metric	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GPB	FL	OIL	WLC	815	990	1,017	1,435	1,562	1,60[illegible]	1,496	1,528	1,455	1,309	1,355	1,240
GPB	FL	OIL	Ave CR	3.2	3.1	1.9	1.41	0.85	0.50	0.49	0.32	0.42	0.34	0.33	0.43
GPB	FL	OIL	SD CR	8.6	10.4	5.1	6.94	3.94	2.07	3.75	0.57	0.84	0.90	0.67	2.47
GPB	FL	OIL	WLC < 2	628	759	874	1,296	1,474	1,556	1,466	1,514	1,415	1,288	1,342	1,234
GPB	FL	OIL	% WLC < 2mpy	77%	77%	86%	90%	94%	97%	98%	99%	97%	98%	99%	100%
GPB	FL	PW/SW	WLC	81	106	154	198	184	195	171	181	161	131	137	129
GPB	FL	PW/S[illegible]	Ave CR	3.5	6.6	7.4	3.18	2.73	0.87	1.44	1.41	1.61	1.86	3.11	1.54
GPB	FL	PW/SW	SD CR	4.4	9.1	15.4	9.52	6.15	1.77	3.72	2.42	2.77	2.54	5.39	2.63
GPB	FL	PW/SW	WLC < 2	43	42	86	162	140	168	139	147	124	89	90	98
GPB	FL	PW/SW	%<2mpy	53%	40%	56%	82%	76%	86%	81%	81%	77%	68%	66%	76%
GPB	FL	PO	WLC		16	23	24	34	44	32	34	36	22	28	40
GPB	FL	PO	Ave CR		0.4	0.6	0.13	0.23	0.13	0.16	0.14	0.17	0.08	0.09	0.11
GPB	FL	PO	SD CR		0.4	0.4	0.17	0.29	0.19	0.11	0.05	0.07	0.06	0.03	0.04
GPB	FL	PO	WLC < 2		16	23	24	34	44	32	34	36	22	28	40
GPB	FL	PO	%< 2 mpy		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
GPB	WL	OIL	WLC	6,894	5,716	5,057	5,330	6,670	6,883	6,491	6,267	6,321	4,921	5,367	4,732
GPB	WL	OIL	Ave CR	3.4	4.2	2.9	2.73	2.22	0.93	0.71	0.55	0.74	0.64	0.57	0.47
GPB	WL	OIL	SD CR	7.8	7.9	4.5	6.94	6.16	2.33	3.68	1.20	1.49	1.60	1.12	1.18
GPB	WL	OIL	WLC < 2	4,588	3,091	2,901	3,788	5,[illegible]80	6,104	6,107	6,021	5,833	4,593	5,029	4,541
GPB	WL	OIL	%< 2 mpy	67%	54%	57%	71%	76%	89%	94%	96%	92%	93%	94%	96%
GPB	WL	Majority PW	WLC	531	514	662	829	976	1,073	966	740	699	659	464	296
GPB	WL	Majority PW	Ave CR	5.8	3.5	1.9	0.80	0.86	0.35	2.44	0.47	0.27	1.43	0.29	0.11
GPB	WL	Majority PW	SD CR	12.8	4.8	1.9	1.19	8.68	2.26	12.05	1.64	0.43	8.55	0.88	0.15
GPB	WL	Majority PW	WLC < 2	345	307	467	760	947	1,047	886	716	690	598	449	296
GPB	WL	Majority PW	% WLC <2 mpy	65%	60%	71%	92%	97%	98%	92%	97%	99%	91%	97%	100%
GPB	WL	100% PW	WLC	282	304	286	485	604	717	721	524	45[illegible]	473	332	252
GPB	WL	100% PW	Ave CR	4.6	4.2	2.1	0.81	1.10	0.35	2.90	0.40	0.30	1.92	0.29	0.11
GPB	WL	100% PW	SD CR	9.3	5.3	2.0	1.19	10.98	2.62	13.64	1.50	0.51	10.05	0.97	0.15
GPB	WL	100% PW	WLC < 2	190	158	192	447	589	[illegible]03	658	512	450	416	323	252
GPB	WL	100% PW	% WLC < 2mpy	67%	52%	67%	92%	98%	98%	91%	98%	98%	88%	97%	100%
GPB	WL	Majority SW	WLC	434	410	384	317	16[illegible]	56	44	82	98	44	25	17
GPB	WL	Majority SW	Ave CR	2.0	13.0	6.5	2.63	3.25	0.65	0.96	1.82	1.78	6.01	6.58	0.78
GPB	WL	Majority SW	SD CR	5.5	16.1	7.5	3.86	5.26	1.20	1.14	2.36	2.77	6.88	5.27	0.72
GPB	WL	Majority SW	WLC < 2	392	103	135	203	110	53	38	61	78	16	7	16
GPB	WL	Majority SW	% WLC < 2mpy	88%	25%	35%	64%	[illegible]	[illegible]5%	86%	74%	80%	36%	28%	94%
GPB	WL	100% SW	WLC	184	194	176	189	78	[illegible]2	44	70	86	16	21	17
GPB	WL	100% SW	Ave CR	2.6	18.2	5.[illegible]	2.80	2.86	0.6[illegible]	0.96	1.82	1.89	1.92	7.46	0.78
GPB	WL	100% SW	SD CR	7.1	19.0	8.[illegible]	4.43	5.39	1.24	1.14	2.50	2.93	1.07	5.28	0.72
GPB	WL	100% SW	WLC < 2	160	38	81	130	54	49	38	52	68	12	5	16
GPB	WL	100% SW	% WLC < 2mpy	87%	20%	46%	69%	69%	94%	86%	74%	79%	75%	24%	94%

Table 5.1 GPB Flow and Well Line General Corrosion Rate Data Summary

BU	Equip	Service	Metric	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GPB	FL	OIL	WLC	815	990	1,017	1,435	1,562	1,602	1,496	1,528	1,455	1,309	1,355	1,240
GPB	FL	OIL	Ave P CR	7.2	5.6	4.4	9.48	7.80	6.86	2.96	1.63	1.89	1.26	0.73	0.65
GPB	FL	OIL	SD P CR	22.6	15.3	14.2	24.31	15.00	14.03	6.67	6.14	7.69	10.52	3.91	8.57
GPB	FL	OIL	P WLC < 20	717	905	960	1,307	1,465	1,545	1,470	1,505	1,422	1,294	1,334	1,238
GPB	FL	OIL	% P WLC <20mpy	88%	91%	94%	91%	94%	96%	98%	98%	98%	99%	98%	100%
GPB	FL	PW/SW	WLC	81	106	154	198	184	195	171	181	161	131	137	129
GPB	FL	PW/SW	Ave P CR	8.5	15.8	17.3	17.03	14.40	15.26	11.36	5.31	6.47	9.37	13.12	7.89
GPB	FL	PW/SW	SD P CR	8.5	5.4	8.6	6.60	5.40	4.10	3.01	2.53	2.32	0.91	0.01	0.01
GPB	FL	PW/SW	P WLC < 20	80	97	140	190	178	195	170	181	161	131	134	129
GPB	FL	PW/SW	% P WLC <20mpy	99%	92%	91%	96%	97%	100%	99%	100%	100%	100%	98%	100%
GPB	FL	PO	WLC		16	23	24	34	44	32	34	36	22	28	40
GPB	FL	PO	Ave P CR		0.5	0.7	1.88	2.56	3.73	2.19	1.26	1.44	1.05	0.77	0.35
GPB	FL	PO	SD P CR		1.2	2.5	3.42	4.64	4.31	5.65	2.43	3.49	3.47	3.92	2.21
GPB	FL	PO	P WLC < 20		16	23	24	34	44	31	34	36	22	26	40
GPB	FL	PO	% P WLC <20mpy		100%	100%	100%	100%	100%	97%	100%	100%	100%	93%	100%
GPB	WL	OIL	WLC	6,894	5,716	5,057	5,330	6,670	6,883	6,491	6,267	6,321	4,921	5,367	4,737
GPB	WL	OIL	Ave P CR	7.3	9.3	5.1	11.56	11.85	5.25	3.23	2.79	3.30	1.96	1.70	1.43
GPB	WL	OIL	SD P CR	22.4	24.0	14.2	32.25	29.20	14.64	9.95	7.88	10.13	6.42	5.60	5.21
GPB	WL	OIL	P WLC < 20	5,959	5,048	4,723	4,658	5,778	6,600	6,326	6,141	6,132	4,815	5,291	4,691
GPB	WL	OIL	% P WLC <20mpy	86%	88%	93%	87%	87%	96%	97%	98%	97%	98%	99%	99%
GPB	WL	Majority PW	WLC	531	514	662	829	976	1,073	966	740	699	659	464	302
GPB	WL	Majority PW	Ave P CR	34.1	24.7	15.8	20.18	15.02	9.65	20.65	8.87	4.65	6.69	2.95	1.14
GPB	WL	Majority PW	SD P CR	41.1	31.9	27.1	29.05	29.64	28.96	58.54	26.07	9.75	17.52	8.97	3.35
GPB	WL	Majority PW	P WLC < 20	258	294	499	574	802	968	807	674	670	579	452	301
GPB	WL	Majority PW	% P WLC < 20mpy	49%	57%	75%	69%	82%	90%	84%	91%	96%	88%	97%	100%
GPB	WL	100% PW	WLC	282	304	286	485	604	717	721	524	459	473	332	252
GPB	WL	100% PW	Ave P CR	33.1	23.3	13.3	20.74	15.15	7.60	22.23	7.13	4.68	8.13	2.77	1.06
GPB	WL	100% PW	SD P CR	38.3	31.0	20.1	30.96	30.19	19.29	64.18	25.49	11.14	19.97	9.69	3.36
GPB	WL	100% PW	WLC < 20	131	174	222	331	500	659	603	489	438	401	324	251
GPB	WL	100% PW	% P WLC <20mpy	46%	57%	78%	68%	83%	92%	84%	93%	95%	85%	98%	100%
GPB	WL	Majority SW	WLC	434	410	384	317	162	56	44	82	98	44	25	17
GPB	WL	Majority SW	Ave P CR	4.7	17.3	9.5	11.36	16.88	1.50	1.55	5.62	6.61	18.80	29.33	10.18
GPB	WL	Majority SW	SD P CR	15.6	44.3	14.2	15.43	23.11	4.57	2.31	8.16	10.40	18.59	27.35	21.16
GPB	WL	Majority SW	P WLC < 20	404	320	331	263	115	55	44	80	92	24	15	14
GPB	WL	Majority SW	% P WLC < 20mpy	93%	78%	86%	83%	71%	98%	100%	98%	94%	55%	60%	82%
GPB	WL	100% SW	WLC	184	194	176	189	78	52	44	70	86	16	21	17
GPB	WL	100% SW	Ave P CR	5.2	13.3	7.8	9.09	10.10	0.54	1.55	5.74	5.57	9.13	31.62	10.18
GPB	WL	100% SW	SD P CR	18.9	18.8	[illegible]	13.41	19.87	2.18	2.31	8.49	6.38	7.30	29.49	21.16
GPB	WL	100% SW	P WLC < 20	172	157	156	162	62	52	44	68	82	[illegible]	12	14
GPB	WL	100% SW	% P WLC <20mpy	93%	81%	89%	86%	79%	100%	100%	97%	95%	88%	57%	82%

Table 5.2 GPB Flow and Well Line Pitting Rate Data Summary

BU	Type	Service	Result	1995	1996	1997	1998	1999	2000	2001	2002	2003
GPB	FL	OIL	I	367	935	1,167	407	239	67	60	101	152
GPB	FL	OIL	NC	15,239	15,795	16,618	14,938	12,125	8,213	7,181	8,858	9,087
GPB	FL	OIL	NL	3,641	2,119	1,981	465	380	148	1,715	1,876	1,951
GPB	**FL**	**OIL**	**Total**	**19,247**	**18,849**	**19,766**	**15,810**	**12,744**	**8,428**	**8,956**	**10,835**	**11,190**
GPB	FL	WTR	I	171	123	153	191	71	17	43	138	170
GPB	FL	WTR	NC	1,163	1,076	1,123	1,555	1,559	717	1,093	1,142	1,482
GPB	FL	WTR	NL	422	115	136	87	77	61	343	360	218
GPB	**FL**	**WTR**	**Total**	**1,756**	**1,314**	**1,412**	**1,833**	**1,707**	**795**	**1,479**	**1,640**	**1,870**
GPB	**FL**	**Total**	**Total**	**21,003**	**20,163**	**21,178**	**17,643**	**14,451**	**9,223**	**10,435**	**12,475**	**13,060**
GPB	WL	OIL	I	642	917	875	605	311	262	213	274	322
GPB	WL	OIL	NC	2,462	3,520	3,411	4,107	3,648	4,142	5,518	7,144	6,577
GPB	WL	OIL	NL	963	1,787	1,980	707	575	527	2,468	3,522	2,287
GPB	**WL**	**OIL**	**Total**	**4,067**	**6,224**	**6,266**	**5,419**	**4,534**	**4,931**	**8,199**	**10,940**	**9,186**
GPB	WL	WTR	I	222	262	201	210	74	126	77	123	149
GPB	WL	WTR	NC	1,018	1,525	1,073	1,613	1,403	1,736	1,276	1,135	1,319
GPB	WL	WTR	NL	614	360	635	223	176	260	486	516	360
GPB	**WL**	**WTR**	**Total**	**1,854**	**2,147**	**1,909**	**2,046**	**1,653**	**2,122**	**1,839**	**1,774**	**1,828**
GPB	**WL**	**Total**	**Total**	**5,921**	**8,371**	**8,175**	**7,465**	**6,187**	**7,053**	**10,038**	**12,714**	**11,014**
GPB	**Total**	**Total**	**Total**	**26,924**	**28,534**	**29,353**	**25,108**	**20,638**	**16,276**	**20,473**	**25,189**	**24,074**

Table 5.3 GPB Flow and Well Line Inspection Data

Corrosion, Inspection and Chemical (CIC) Group
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Anchorage
Alaska

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PRUDHOE BAY CORROSION CRISIS, 8/18/06 (FILE 8)

2004

bp

Annual Report to Alaska Department of Environmental Conservation

Commitment to Corrosion Monitoring Year 2004

Prepared by

Corrosion, Inspection and Chemicals (CIC) Group
BP Exploration (Alaska), Inc.

March 2005

Commitment to Corrosion Monitoring

Year 2004

Foreword

This is the fifth annual report that meets the commitment made by BPXA to the State of Alaska to provide a regular review of BPXA's corrosion monitoring and management practices for non-common carrier pipelines on the North Slope. The contents of this report reflect the Work Plan[1] agreed jointly between BPXA, Phillips and ADEC, the Guide for Performance Metric Reporting[2], and feedback from previous ADEC reports. The report is divided into 2 main parts.

> **Part 1** contains information regarding the BPXA operated fields within the Greater Prudhoe Bay (GPB) Performance Unit. This consists principally of fluids produced from Prudhoe Bay, Lisburne, Point McIntyre and Niakuk field areas but also includes smaller volumes of fluids from satellite accumulations.
>
> **Part 2** contains information regarding the BPXA operated fields within the Alaska Consolidated Team (ACT) Performance Unit. This consists principally of fluids from Endicott, Badami, Milne Point and Northstar field areas. As with GPB, several smaller satellite accumulations are also produced through ACT facilities.

The report provides an overview of the corrosion management process, and provides data and discussion of the corrosion control, monitoring, inspection and fitness-for-service programs. These individual programs, in concert, form the core of the integrity/corrosion management system designed to deliver our corporate goal of no accidents, no harm to people and no damage to the environment[3]. The program also reflects the core values of BP: innovation, performance driven, environmental leadership and progressive.

Innovation is evident in several areas, from the development of more effective corrosion inhibitors and corrosion inhibition programs, to the application of new inspection technologies. These innovations are only made possible by working closely with partners, major suppliers and the regulatory community, to bring the best available technology to Alaskan oilfields.

Performance management and the drive for improved performance are central to all aspects of the corrosion management program. This report demonstrates an on-going effort to improve corrosion management. Since 1992, corrosion rates have been reduced by almost a factor of 10 in the cross-country pipelines that transport a mixture of oil, water and gas (3-phase). Consistent with the pledge to report openly both good and bad performance, the report highlights areas for improvement and the plans in-place to deliver performance improvement.

Environmental protection and corrosion management are closely linked. The improvements in corrosion management have resulted in lower corrosion rates and a lower risk of loss of containment. Opportunities to improve environmental performance still exist and the investment in continuous corrosion inhibitor injection at Drill Site 5 and 7 as well as the continued effort on our external corrosion inspection program is evidence of this on-going commitment.

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[1] Appendix 2 (a) 2000 Work Plan
[2] Appendix 2 (b) Guide for Performance Metric Reporting
[3] BP HSE Policy Statement, EJP Browne, Group CEO, January, 1999, http://www.bp.com/

Progressive evolution of the corrosion management programs is an on-going activity driven by changing field conditions and the desire to improve performance. Progress involves the continued refinement of the existing programs, but also, the development and implementation of new programs and corrosion management technologies.

The current corrosion management process has delivered a significantly improved level of corrosion control. Notwithstanding the successes, the corrosion management program must remain focused on the future in order to maintain the current level of control and, where necessary, implement the actions necessary to improve performance.

The continuous improvement of the corrosion management programs has enabled BPXA to deliver the programs strategic objectives of:

- Minimizing the health, safety and environmental impacts of loss of containment due to corrosion
- Providing a fit-for-service infrastructure for the remainder of field life
- Producing satellite accumulations through existing equipment and pipe-work
- Providing an infrastructure capable of supporting gas sales in the future

In addition, with the information in this report, BPXA intends to build a healthy relationship with the North Slope stakeholders through consultation, open reporting and striving to raise the standards of the industry.

BP Exploration (Alaska) Inc.
March 2005

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CORRECTION

THE FOLLOWING DOCUMENT(S)
HAVE BEEN REFILMED TO
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Central Microfilm Services
Departement of Education & Early Development
State of Alaska

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Section A

Charter Agreement – Corrosion Related Commitments

Section A Charter Agreement – Corrosion Related Commitments

The BPXA contact for all corrosion matters relating to the Charter Agreement is,

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Section A.1 Project Achievements

Oct-Nov 2000	Work Plan agreed between BPXA/PAI and ADEC (Appendix 2a)
March 2001	1st Annual Report submitted to ADEC
April 2001	1st 2001 Meet and Confer session held
Oct-Dec 2001	Consultations with ADEC and ADEC's consultant
November 2001	2nd 2001 Meet and Confer session held
Dec 01-Jan 02	Developed and agreed corrosion management metrics
February 2002	BPXA/PAI and ADEC agreed on performance metrics (Appendix 2b)
March 2002	2nd Annual Report submitted to ADEC
April 2002	1st 2002 Meet and Confer session held
November 2002	2nd 2002 Meet and Confer session held
March 2003	3rd Annual Report submitted to ADEC
May 2003	1st 2003 Meet and Confer session held
October 2003	2nd 2003 Meet and Confer session held
March 2004	4th Annual Report submitted to ADEC
April 2004	1st 2004 Meet and Confer session held
August 2004	North Slope Field Trip
March 2005	5th Annual Report submitted to ADEC

Section A.2 Annual Charter Timetable

March 31st	Annual Report submitted
April 30th	1st Semi-Annual Review/Meet and Confer
October 31st	2nd Semi-Annual Review/Meet and Confer

Part 1 – Greater Prudhoe Bay Performance Unit

Section B

2004 Corrosion Program Summary

Section B 2004 Corrosion Program Summary

Section B.1 Introduction

This section provides a summary of key performance indicators (KPI) for 2004. Additional information regarding the Corrosion Management System and historical program data and development are shown in subsequent sections of the report.

Section B.2 Corrosion Monitoring

The plan and objective for corrosion monitoring is to measure the effectiveness of the mitigation programs. The primary monitoring techniques are intrusive weight loss coupons (WLC) and Electrical Resistance Probes (ER Probe) which provide the feedback for corrective action when control targets are exceeded.

Program:	Weight Loss Coupon
Target:	<2 mills per year (mpy)
KPI:	% Conformance WLC <2 mpy
Section Reference:	Section C Weight Loss Coupons and ER Probes

1. 7,185 coupons were analyzed to monitor the effectiveness of the mitigation programs.
2. 3-phase flow line WLC data showed 98% were <2 mpy with an average corrosion rate of 0.4 mpy.
3. 3-phase well line WLC data showed 94% were <2 mpy with an average corrosion rate of 0.6 mpy.
4. Water injection flow line (produced and seawater) WLC were 86% <2 mpy with an average corrosion rate of 1.0 mpy.
5. 100% produced water service well line WLC showed 99% less than 2 mpy and average corrosion rate of 0.1 mpy.
6. 100% seawater service well line WLC showed 100% less than 2 mpy and average corrosion rate of 0.3 mpy.
7. Majority service produced water well line WLC showed 98% less than 2 mpy and average corrosion rate of 0.2 mpy.
8. Majority service seawater well line WLC showed 85% less than 2 mpy and average corrosion rate of 1.4 mpy.

Program:	Electrical Resistance Probe
Target:	<2 mills per year (mpy)
KPI:	Conformance <2 mpy
Section Reference:	Section C.3 Electrical Resistance Probes

9. 3-phase flow line ER Probes showed 92% of the data was <2 mpy.

The monitoring data for the majority of the 3-phase production system demonstrate an effective level of corrosion control as direct result of the mitigation programs. However, there were two unforeseen events that originated in the 4th Quarter, which resulted in several 3-phase WLC exceeding the 2 mpy target. These events were: 1) corrosion inhibitor instability at winter temperature which caused blockage of some chemical inhibition delivery systems, and 2) material incompatibility with a test corrosion inhibitor degrading the delivery system tubing.

The monitoring data for the water injection system also demonstrate an effective level of corrosion control although the data show a slight reduction in corrosion control in majority service seawater well lines where service changes between produced water and seawater occur

Section B.3 Corrosion Mitigation/Corrosion Inhibition

The plan and objective for corrosion mitigation is to control corrosion rates to acceptable levels. For internal corrosion control the principal means of mitigation is through the application of corrosion inhibitors.

Program:	Corrosion Mitigation – Corrosion Inhibitor (CI)
Target:	Control corrosion to acceptable levels
KPI:	Monitoring <2 mpy and inspection percent of increases, Target versus actual CI usage, injection volumes (ppm)
Section Reference:	Section D Chemical Optimization Activities

1. The field wide average inhibitor concentration increased from 147 to 151 ppm.
2. The corrosion inhibitor usage was 2.71 million gallons which was delivered at 99% of target.

The effectiveness of corrosion mitigation as a result of the application of corrosion inhibition is determined from corrosion monitoring and inspection programs. Corrosion monitoring data are a leading indicator and inspection data are a lagging indicator of corrosion mitigation efforts. There is a strong correlation between monitoring and inspection data, which gives confidence mitigation with corrosion inhibition can be managed in a timely manner using monitoring data.

Section B.4 External Inspection Program

The plan and objectives for the External Corrosion Program are comprehensive inspection coverage of equipment susceptible to Corrosion Under Insulation (CUI), minimize loss as a result of external corrosion failures and assure the equipment is fit-for-service (FFS) and safe to operate.

Program:	Corrosion Under Insulation
Target:	35,000 inspections/year
KPI:	% of locations inspected with external corrosion, Leak/Save ratio
Section Reference:	Section E.1 External Inspection

1. There were 35,384 external corrosion inspections completed, 3% were found with corrosion degradation.
2. There were 85 mechanical repairs identified as a result of external corrosion.
3. There were two leaks due to external corrosion, 1 on a 3-phase well line, 1 on a 3-phase flow line.
4. The Leak/Save ratio for the External Corrosion (CUI) Program was 98%.

Unlike internal corrosion, where mitigation can be managed through chemical inhibition, mechanical cleaning and/or operational controls, CUI is managed through detection and repair. Once CUI has been found through inspection activities, locations are scheduled for insulation and by-product removal, fit-for-service assessment, mechanical repair if needed and rehabilitation of the insulation system. The 2004 External Program met the program target completing over 35,000 inspections with a find rate of 3% consistent with recent history. The 85 mechanical repairs is similar the level of repair activity seen in 2003.

Section B.5 Cased Pipe Program

The plan and objective for the Cased Pipe Program is comprehensive inspection coverage of cased pipe segments at road and/or animal crossings. The excavation of crossings, as required, is performed to mitigate active corrosion and assure the equipment is fit-for-service and safe to operate.

Program:	Cased Pipe Inspection
Target:	100 inspection/yr
KPI:	Increases of active corrosion determined from repeat examinations.
Section Reference:	Section E.1.2 Cased Piping Survey Results

1. 108 cased piping segments were re-inspected using ILI or guided-wave inspection techniques.
2. 9 of the inspections showed potential active corrosion sites.
3. 21 cased pipe crossings were either fully or partially excavated and inspected.
4. Minor to moderate corrosion damage was found at 19 locations, no mechanical repairs were required and the damaged areas were rehabilitated.

After completing a baseline survey of all cased pipe segments, a long-term cased piping management strategy was implemented, consisting of repeat inspection and excavations. The long-term cased piping strategy will continue to evolve as the program is refined and more information is available.

Section B.6 Internal Inspection Program

The plan and objective for the Internal Program is comprehensive inspection coverage of equipment susceptible to internal degradation, the assessment of mechanisms and rate of wastage, minimize loss as a result of failures and assure the equipment is fit-for-service and safe to operate.

Program:	Internal Inspection Program
Target:	60,000 inspections/yr split between Field (~25,000) and Facility (~35,000) equipment
KPI:	% of locations inspected with increased metal loss, Leak/Save ratio
Section Reference:	Section E.2 Internal Inspection Program Results

1. There were 11,327 inspections on 3-phase flow lines, with 1% showing an increase.

2. There were 9,724 inspections on 3-phase well lines, with 4% showing an increase.
3. There were 1,897 inspections on water injection flow lines, with 6% showing an increase.
4. There were 2,759 inspections on water injection well lines, with 7% showing an increase.
5. There were 46 mechanical repairs identified as a result of internal corrosion.
6. There was one leak due to internal corrosion on a water injection pigging return well line.
7. The Leak/Save ratio for the Internal Inspection Program was 98%.

For 3-phase production and water injection systems, the inspection program shows a reduction in corrosion activity over the prior year based upon a decline in the percentage of inspection increases.

The number of internal corrosion repairs is higher than recent history. This is the result of two distinct activities: 1) pressure up-rating specific equipment to handle increased seawater capacity, 2) a thorough review of historical data and application of a more conservative fit-for-service criterion.

Section C

Weight Loss Coupons and Probes

Section C Weight Loss Coupons and ER Probes

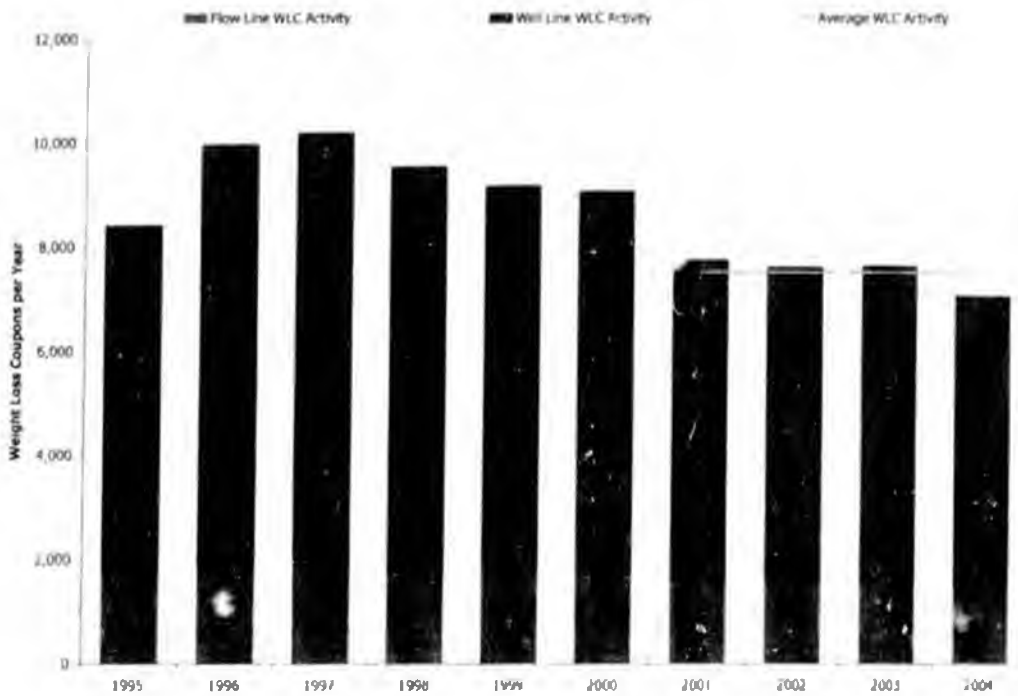
This section summarizes the results of the weight loss coupon corrosion monitoring and ER probe programs. Each of the major service categories are reviewed in turn with the results of the program discussed along with major conclusions and significant recommendations.

The number of weight loss coupon (WLC) monitoring locations by equipment type and service, is summarized in GPB Table C.1. The number of WLC processed over time is presented in GPB Figure C.1.

Detailed data tables for each configuration of equipment type, flow line and well line, and each service category, 3-phase, produced water and seawater, are provided in GPB Table C.6 and **GPB Table C.7**.

Service	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Flow Line										
3 Phase	219	315	268	272	266	254	256	257	255	242
Export/PO	3	7	7	5	5	6	4	6	5	5
Gas	3	3	1	1	1	0	0	0	1	0
Other	5	6	5	7	6	5	6	6	3	5
Water	36	37	45	43	46	45	44	44	48	38
Total	266	368	326	328	324	310	310	313	312	290
Well Line										
3 Phase	1,047	1,168	1,216	1,202	1,166	1,162	1,081	1,096	1,105	1,062
Export/PO	0	3	3	3	3	3	3	0	2	0
Gas	6	7	7	7	6	6	7	6	5	4
Other	8	9	9	7	8	8	6	8	8	6
Water	199	210	211	205	193	186	186	191	173	151
Total	1,260	1,397	1,446	1,424	1,376	1,365	1,283	1,301	1,293	1,223
Grand Total	1,526	1,765	1,772	1,752	1,700	1,675	1,593	1,614	1,605	1,513

GPB Table C.1 Corrosion Monitoring Locations by Equipment and Service



GPB Figure C.1 Corrosion Monitoring Activity Statistics by Equipment

Two corrosion coupons are typically recovered for each WLC pull with the exception of those lines that are regularly maintenance pigged where single flush mounted coupons are installed. The number of coupons, coupons per pull, and pull frequency has been optimized through time to gain greater value from the data obtained by the program.

As discussed in prior reports, there has been a gradual reduction in the number of weight loss coupons being evaluated, which reflects the on-going effort to optimize the program. Following the rationalization in 2000/01, the level of WLC activity has stabilized at ~7,500 coupons per year. The number of weight loss coupons reported for 2004 does not reflect the inventory of coupons that are installed in the system at year-end and still to be 'processed.' The reduction in 2004 coupon numbers therefore represents a timing effect and not a reduction in the program scope or activity level.

Section C.1 Three Phase Production Systems

Section C.1.1 Introduction

The corrosion mechanism of concern in the 3-phase production system is CO_2 corrosion, in which CO_2 from the produced fluids dissolves and dissociates in the produced water to form an acidic environment that is, if untreated, corrosive to carbon steel[4,5]. The primary corrosion control method is the continuous addition of corrosion inhibitor in the flow lines and a mix of continuous and batch inhibitor additions in the well lines. For the 3-

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[4] Corrosion Control in Petroleum Production, Harry G Byers, NACE, 1999
[5] Corrosion Control in Oil and Gas Production, Treseder and Tuttle, NACE, 1998

phase production system the target corrosion rate from weight loss coupons is a general corrosion rate of 2 mpy or less (WLC ≤2 mpy).

The 3-phase production system has seen a consistently strong improvement in corrosion control since the early 1990's with a near order of magnitude reduction in the cross-country flow line corrosion rates. A similar trend is also seen in the inspection history discussed later in Section E. The decrease in corrosion rates in the 3-phase systems is attributable to the implementation and continuation of the aggressive corrosion inhibition program. The correlation between corrosion inhibitor concentration and corrosion rates in 3-phase flow lines is discussed in detail in Section D.

Section C.1.2 Cross Country Flow Line Coupons

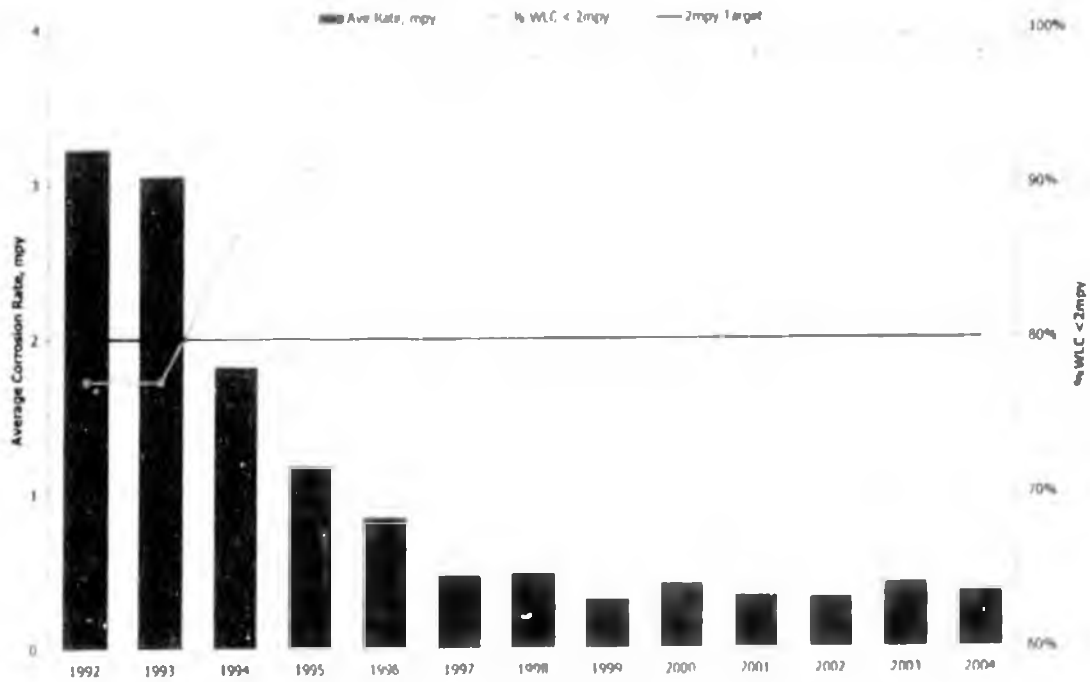
GPB Figure C.2 shows the average corrosion rate and percentage of coupons meeting the performance standard target since 1992. The results show the percentage of conformant flow lines has improved consistently over the last decade. The average corrosion rate for 2004 across GPB is approximately a factor of 10 lower than the corrosion rates from the early 1990's.

The slight decrease in the percentage of WLC <2 mpy can be attributed to three main causes. First, there were two flow lines that had an increase in fluid corrosivity. Second, there were precipitation problems with the winter corrosion inhibitor that lead to plugging of several continuous injection systems. Lastly, there was an incompatible test corrosion inhibitor which required the shutdown of the injection system in early 2005. Although the system shutdown occurred in 2005, the coupon reporting metrics (i.e. exposure mid-date) was in 2004. Refer to Section H.1.5 for details and corrective actions.

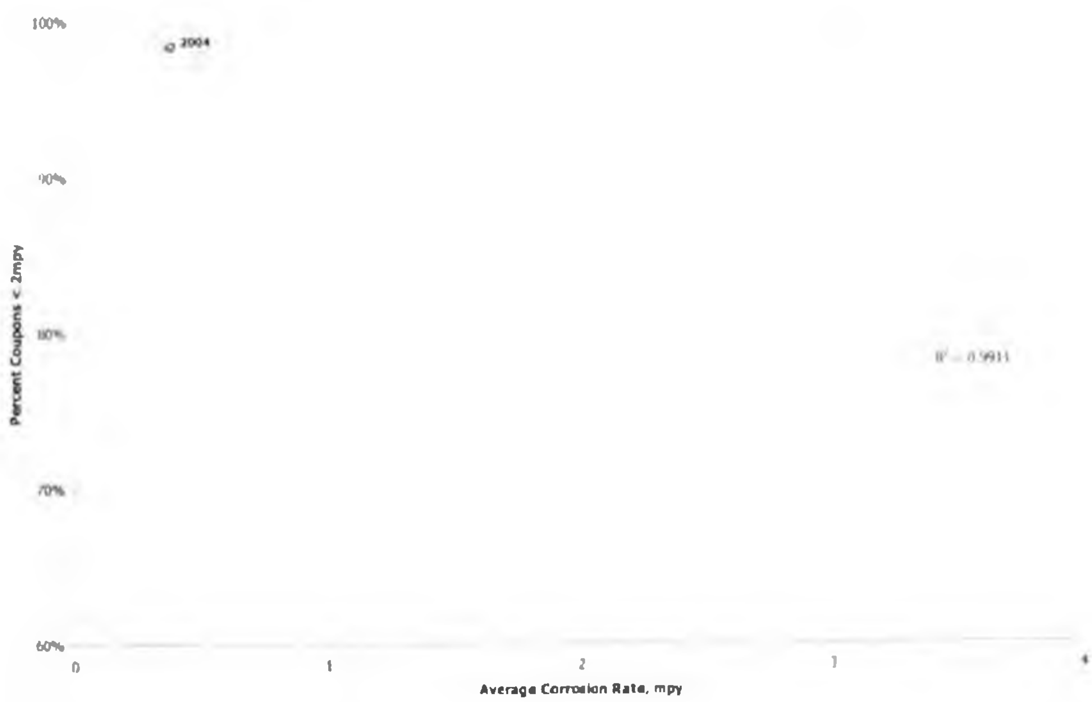
The overall reduction in corrosion rate is a direct result of the implementation of an aggressive corrosion mitigation program consisting primarily of continuous addition of corrosion inhibitor into the production fluids. This mitigation program has been implemented at considerable capital and operating expense but has resulted in flow lines which are now expected to be fit-for-service (FFS) for approximately 10 times as long as that expected in the early 1990's due to the reduction in corrosion rate.

GPB Figure C.3 shows the correlation between average corrosion rate and the percentage of weight loss coupons meeting the 2 mpy target. As might be expected, there is a very strong correlation between these two metrics. However, they should be viewed as being complementary. The percentage less than 2 mpy target has the advantage of highlighting non-conformances that would otherwise be lost in the calculation of the average.

Conversely, the average corrosion rate has the advantage of showing the overall performance trend that would otherwise be lost when only looking at the exceptions >2 mpy. Hence, it is necessary to review both metrics in order to gain an overall understanding of the performance of the program.



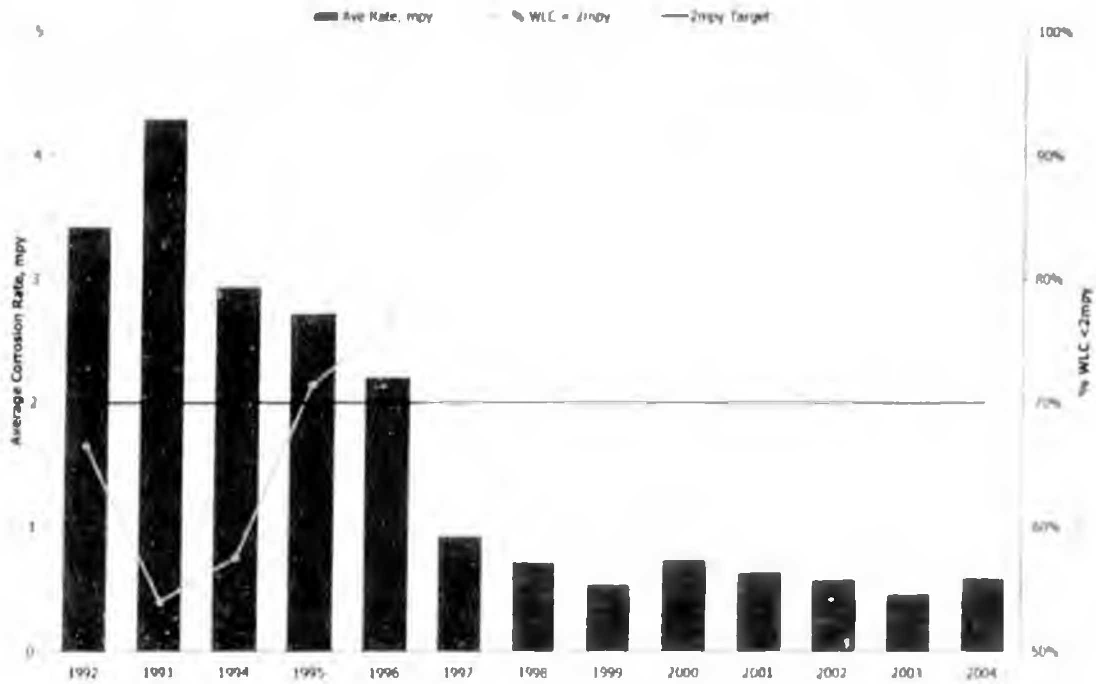
GPB Figure C.2 Flow Line Oil Service Corrosion Rate Trend



GPB Figure C.3 Correlation Between Flow Line Corrosion Rate and Percentage Conformance

Section C.1.3 Well Line Coupons

GPB Figure C.4 shows the average corrosion rate and percentage of WLC ≤2 mpy since 1992. The trends are very similar to those seen in the cross-country oil flow lines, showing a long-term improvement in the level of control from early 1990's to the present day with a slight decrease in performance from 2003 to 2004. This decrease in performance is largely due to the plugging event, previously discussed. Corrective actions are identified in Section H.1.5.



GPB Figure C.4 Well Line Oil Service Corrosion Rate Trend

The long term corrosion control improvement in the well lines is of the same magnitude as that seen in the flow lines with corrosion rates being reduced from an average >4 mpy in 1993 down to an average of 0.5 to 0.6 mpy over the past three years.

Section C.2 Water Injection Systems

The Water Injection System at GPB is comprised of produced water from the primary processing/separation facilities and seawater extracted from the Beaufort Sea and processed through the Seawater Treatment Plant (STP). During 2004, the seawater injection volumes increased from ~650 Mbpd to just over 1,000 Mbpd

As noted in the 2002 Report, the production database has now been linked to the corrosion and inspection database. This dynamic link provides a much more detailed view of service history/changes for the well line equipment, enabling an improved level of data analysis and quality

The reporting format, which augments the performance metrics and was agreed with ADEC, can be summarized as follows:

Report Date Mid point of the WLC's exposure period

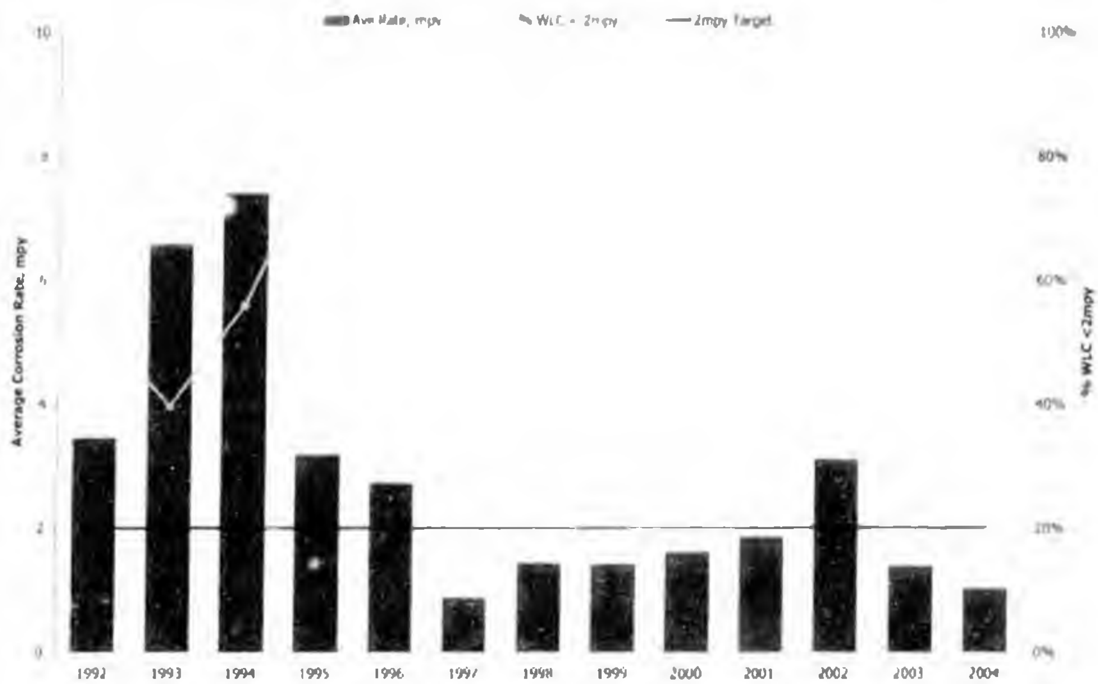
$$\text{Mid Date} = \text{Date In} + \frac{(\text{Date Out} - \text{Date In})}{2}$$

Service Type (a) Average corrosion rate with 100% exposure to service

(b) Average corrosion rate with simple service majority

Section C.2.1 Water Injection System Flow Lines

GPB Figure C.5 is a summary of aggregate data for produced water and seawater flow lines. The data show the 2003 and 2004 WLC corrosion rates have decreased below the 2 mpy target demonstrating improved corrosion control over the past two years.



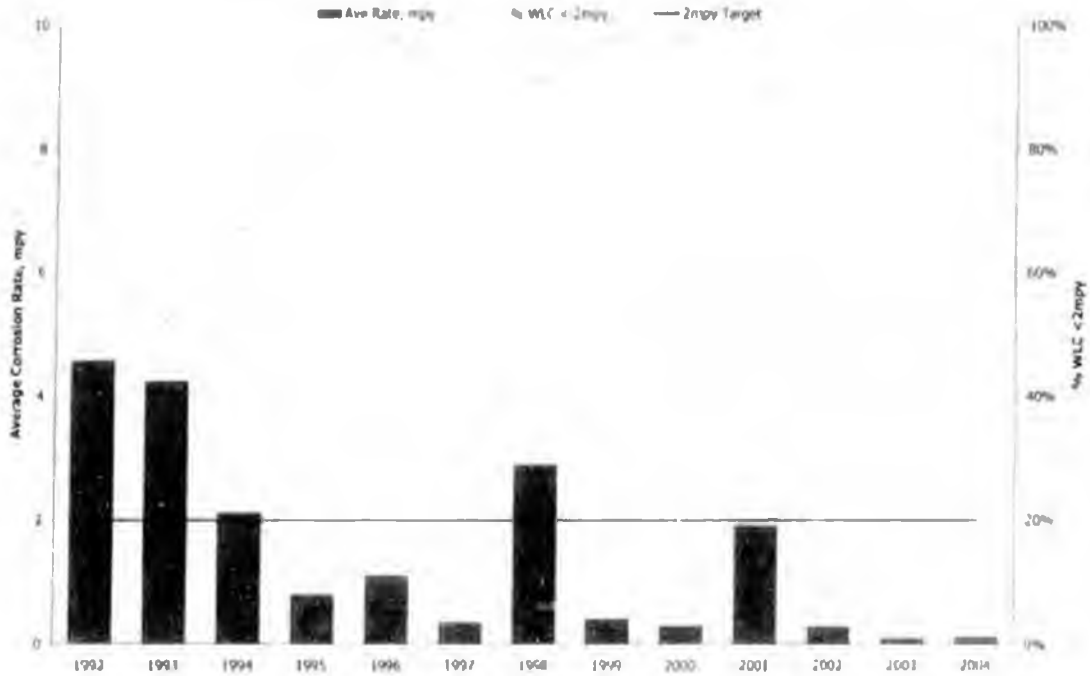
GPB Figure C.5 Flow Line PW/SW Service Corrosion Rate Trend

In summary, the average WLC corrosion rates for the aggregate water injection service continued to improve in 2004. This improvement is attributable to several different activities outlined in Section C.2.2 and Section C.2.3.

Section C.2.2 Produced Water Injection Well Lines

There are a number of corrosion mechanisms of concern in the produced water (PW) injection system. These mechanisms include CO_2 corrosion and differential concentration effects due to the high particulate content of the system. The particulates consist primarily of residual hydrocarbon remaining after the separation process, entrained production chemicals, and iron sulfides.

GPB Figure C.6 through GPB Figure C.8 summarize the historical corrosion rate data for produced water well lines. The data show the general corrosion rates in the produced water system have fallen as the level of inhibition in the 3-phase system was increased and supplemental produced water corrosion inhibitor injection was initiated.



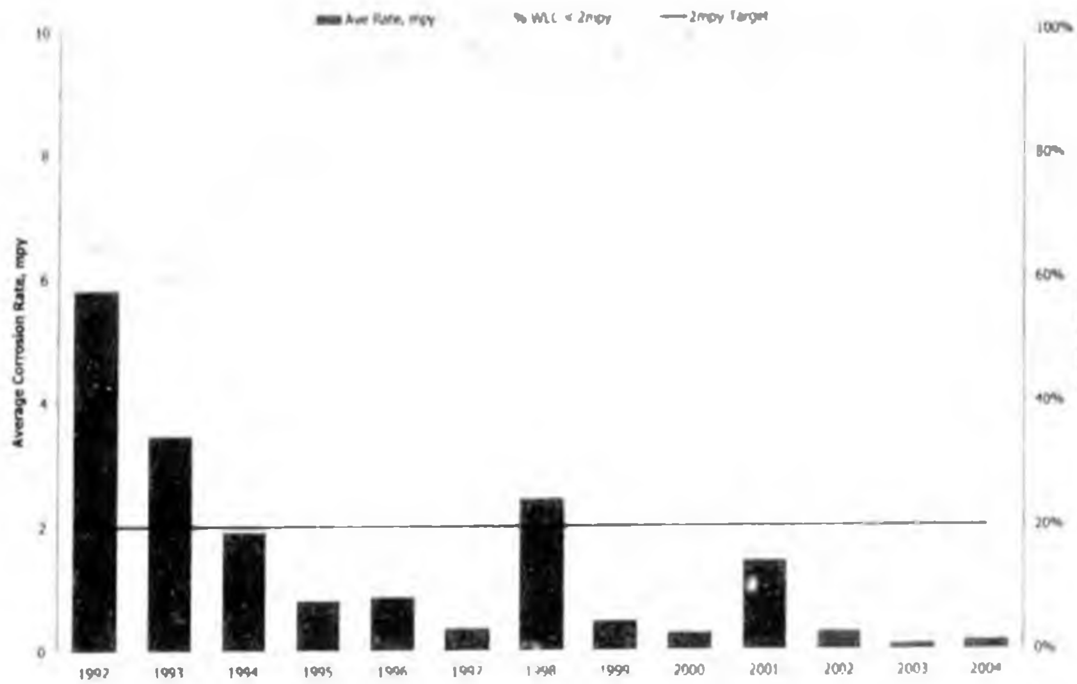
GPB Figure C.6 Corrosion Rates for 100% PW System

GPB Figure C.6 shows the performance for 100% produced water service. The 2004 levels maintained average corrosion rates at ~0.1 mpy and ~100% WLC ≤2 mpy.

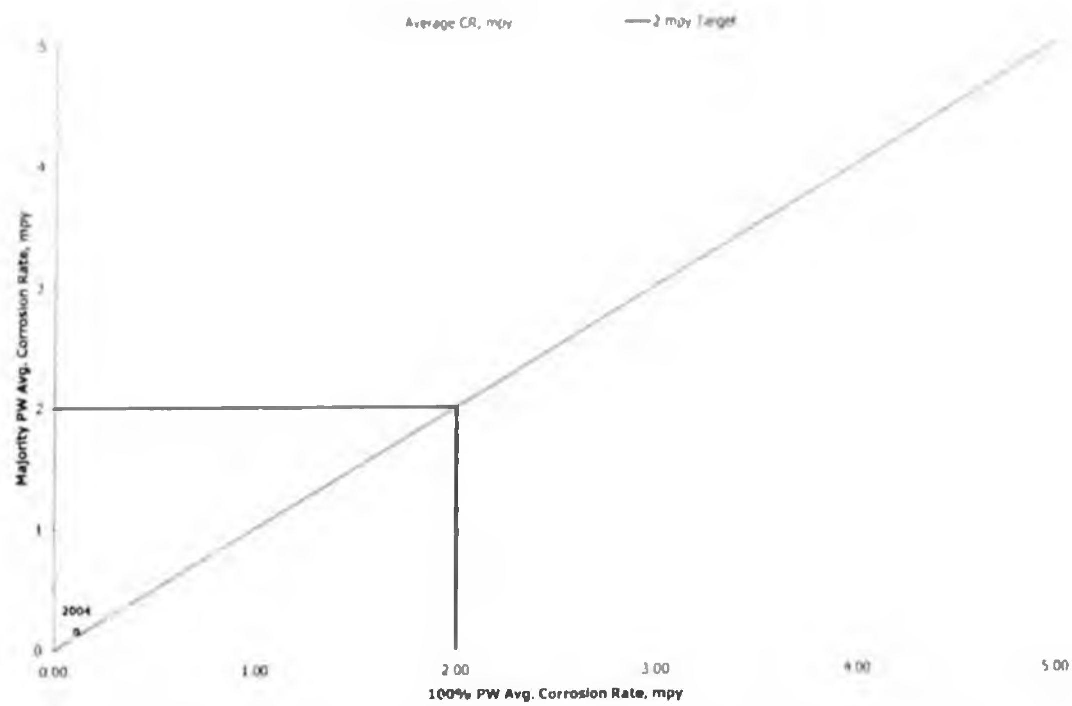
For those coupons where produced water was the majority service, GPB Figure C.7 shows the corrosion rate trends were very similar to those seen for 100% produced water service. The results for 2004 are encouraging in 100% and majority service, but caution is warranted as the data set is limited, and a long-term trend has not been established.

A comparison of the average corrosion rate for produced water between the 100% service and majority service is provided in GPB Figure C.8. The figure shows little difference between the data.

The overall improvement in the performance of the PW system from 2001 to date can be attributed primarily to three factors. First, there was a change in the upstream 3-phase continuous corrosion inhibitor in 2002 that gave more favorable partitioning characteristics to the water phase than the prior product. This had the effect of increasing the levels of corrosion inhibitor carried from the upstream system into the produced water distribution network. The second contributor was the expansion of corrosion mitigation programs specific to the PW system started in 2002. The program now includes limited inhibitor injection in the PW system at FS-1, FS-3, GC-1, GC-2 and GC-3. The third contribution is the increase in field-wide average concentration of 3-phase corrosion inhibitor over time.



GPB Figure C.7 Corrosion Rates for Majority PW System



GPB Figure C.8 Comparison of Corrosion Rates for 100% and Majority PW

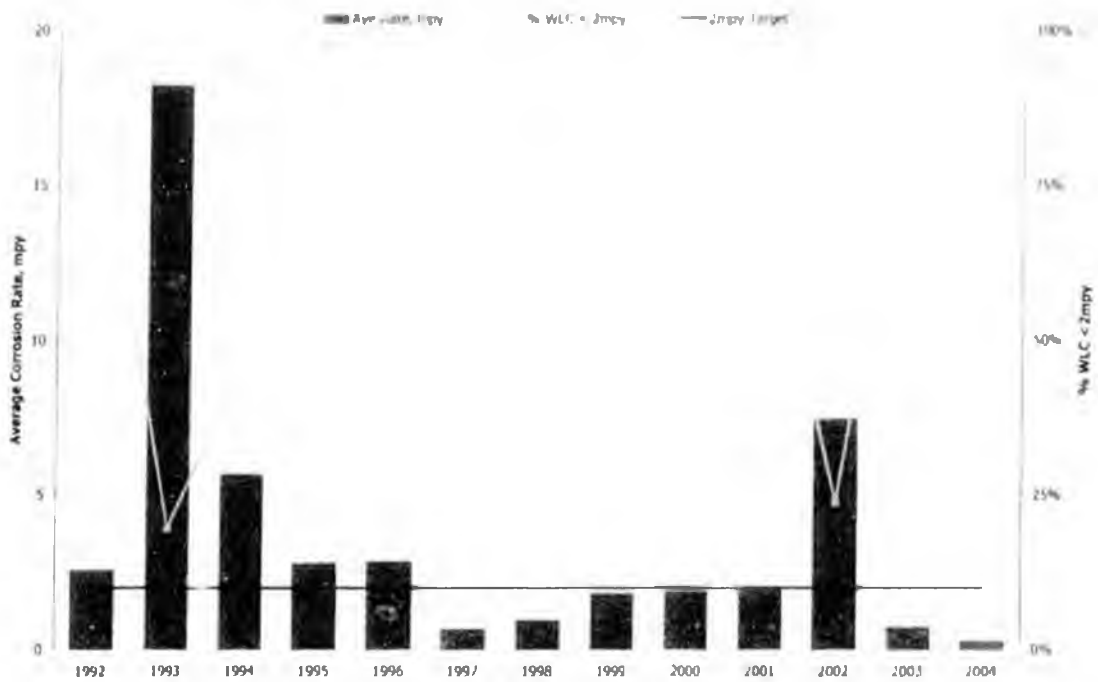
Section C.2.3 Seawater Injection Well Lines

The main corrosion mechanisms in the seawater (SW) injection systems are,

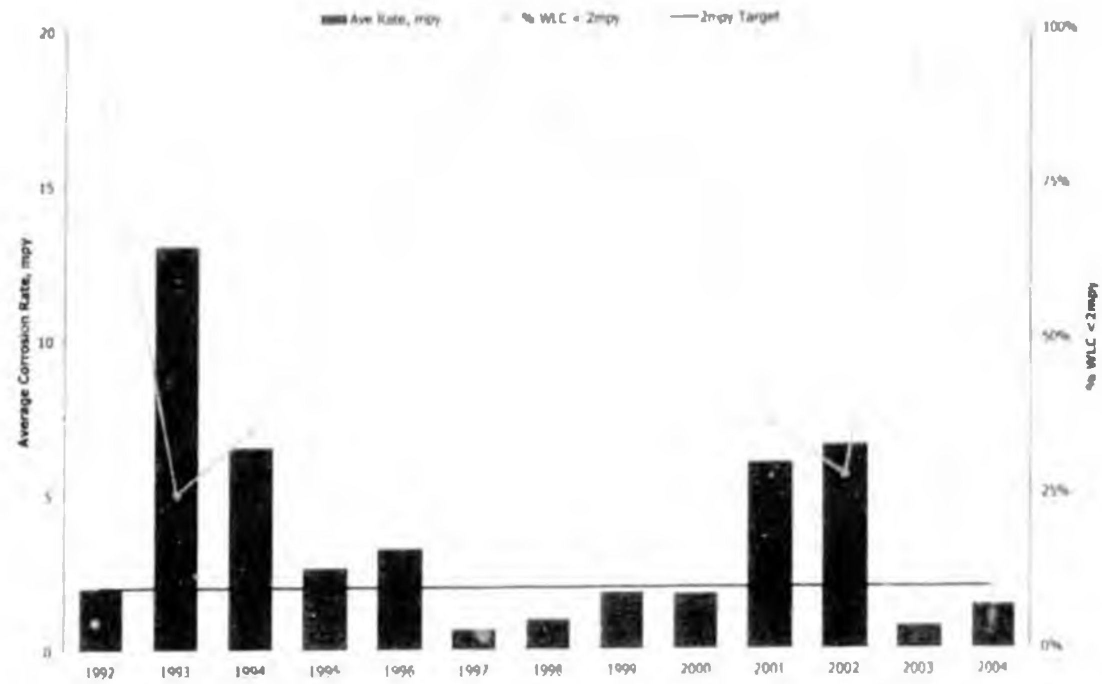
- Dissolved oxygen (DO) corrosion – This mechanism is mitigated by processing the seawater to remove the oxygen. Initial DO removal is achieved mechanically by vacuum stripping, which is then followed by chemical oxygen scavenging.
- Microbiological corrosion (MIC) – MIC is due to the action of anaerobic bacteria, and is mitigated by batch treatment with biocide, after processing to remove DO and prior to seawater transfer to the main cross country flow lines.

As with the PW system, the SW system data are presented as both 100% and majority service for the well line data, along with a comparison of general corrosion rates and pitting corrosion rates.

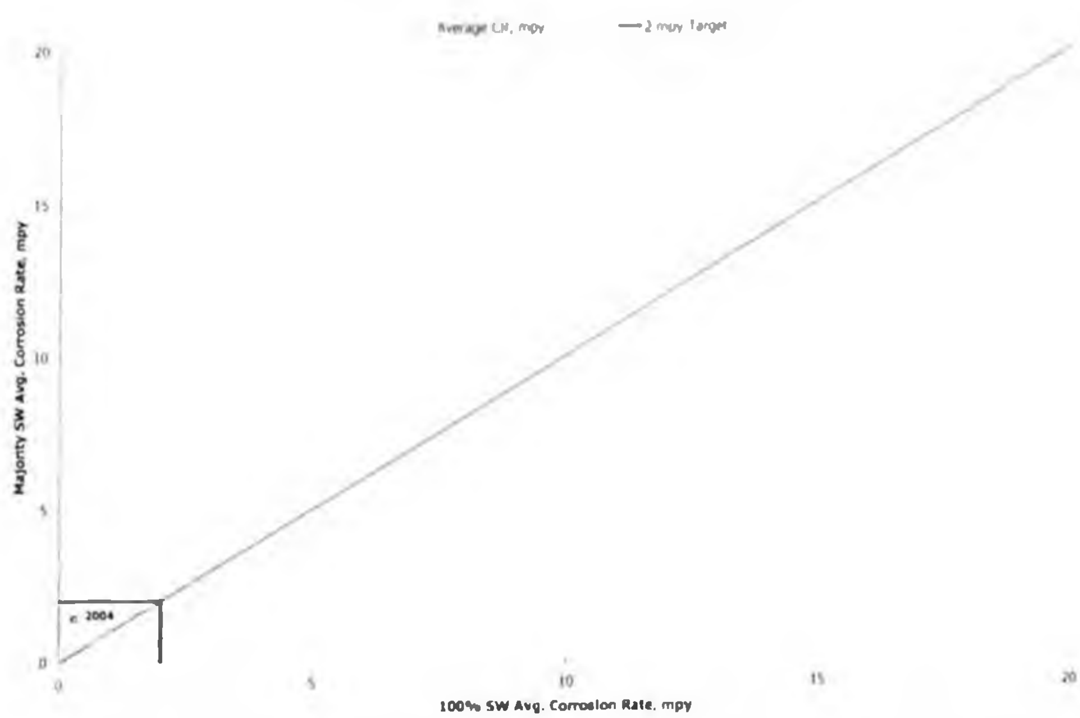
GPB Figure C.9 through GPB Figure C.11 show the corrosion rate trends in the SW system for both 100% SW service and majority SW service. For the 100% SW service, the improvement since 2002 is a result of implementation of the corrective actions outlined in previous reports. For the majority SW service, the decline in performance is believed to be due to a service change between PW and SW. Additional analysis will be performed during 2005 to better understand the difference between 100% and majority service.



GPB Figure C.9 Corrosion Rate for 100% Seawater System

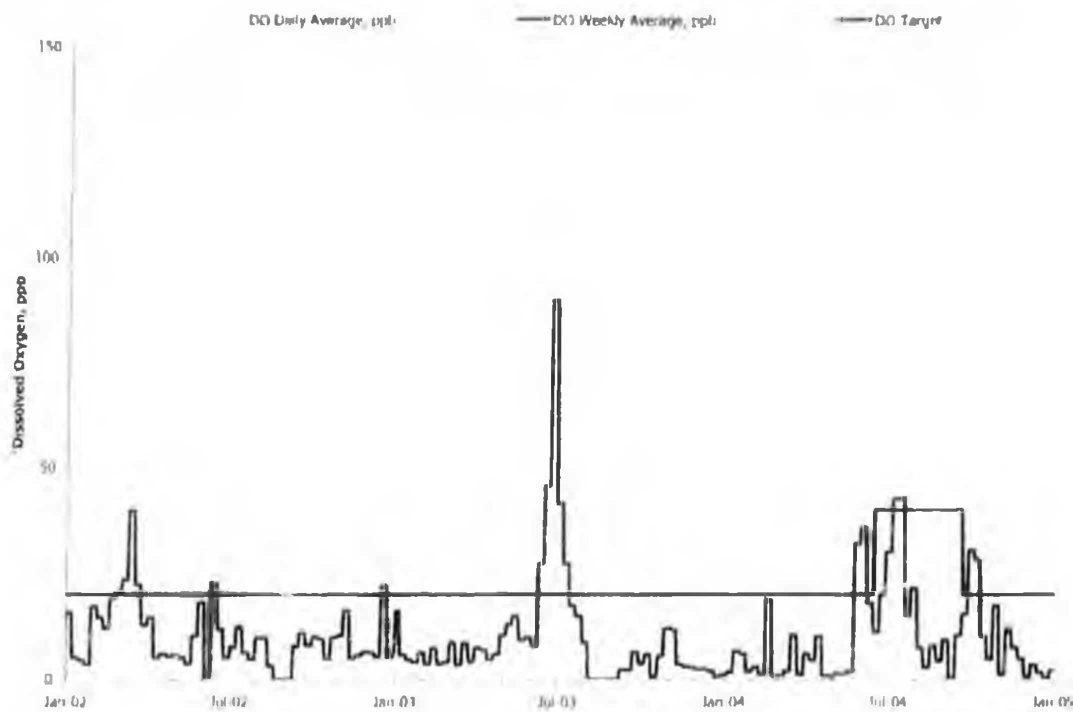


GPB Figure C.10 Corrosion Rates for Majority SW System



GPB Figure C.11 Comparison of Corrosion Rates for 100% and Majority SW System

GPB Figure C.12 shows the daily and weekly average level of dissolved oxygen control in the seawater system from 2002 through 2004. The DO excursion during the summers is due to seasonal decreases in rates of the chemical oxygen scavenging reactions during periods of spring runoff and seawater turbidity. DO control has improved markedly since the second half of 2003, and diligent plant operation continues to deliver good DO control.



GPB Figure C.12 Dissolved Oxygen Control Performance for the Seawater System

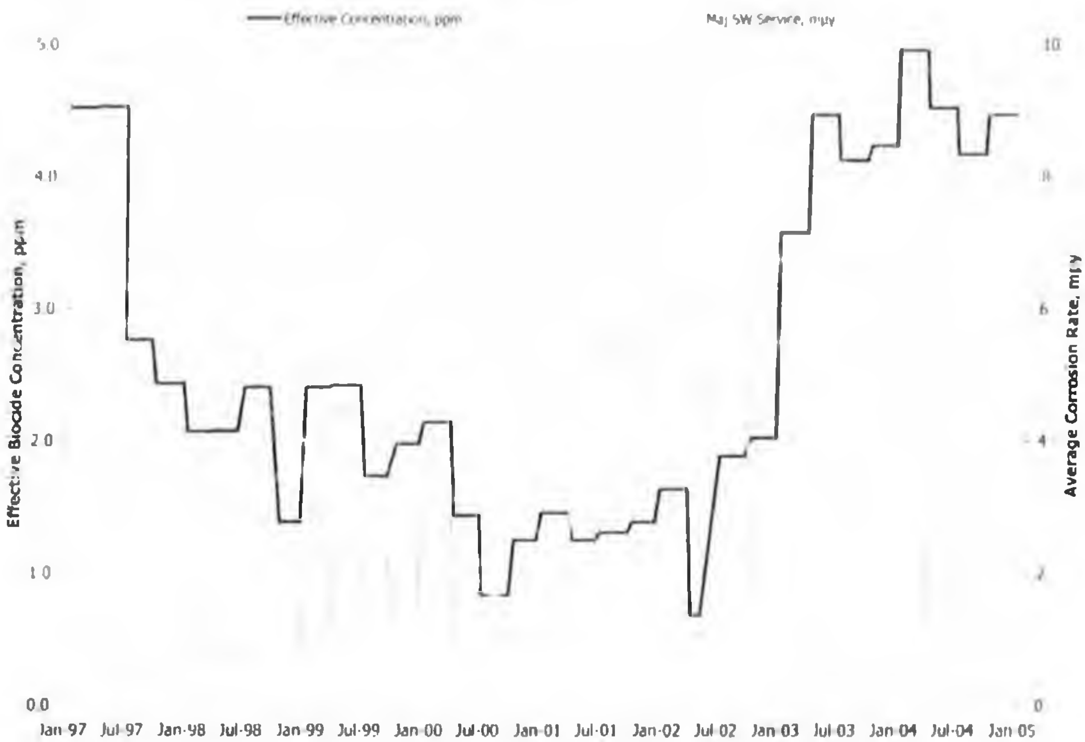
GPB Table C.2 summarizes the changes in the biocide treatment program for the SW system. Biocide dosage was increased in Mar-03 by 50% at STP to increase the effectiveness in downstream parts of the seawater system. This action decreased the downstream coupon corrosion rates faster than expected. In Dec-03, the glutaraldehyde/quaternary amine biocide was replaced temporarily with glutaraldehyde. In Oct-04, the biocide was switched back to glutaraldehyue/quaternary amine.

GPB Figure C.13 shows the corresponding effective concentration of biocide and the average corrosion rate for well line coupons in majority SW service. The beneficial effect of increasing the biocide injection concentration at STP is clearly depicted and helped to reduce seawater system corrosion rates below the 2 mpy target.

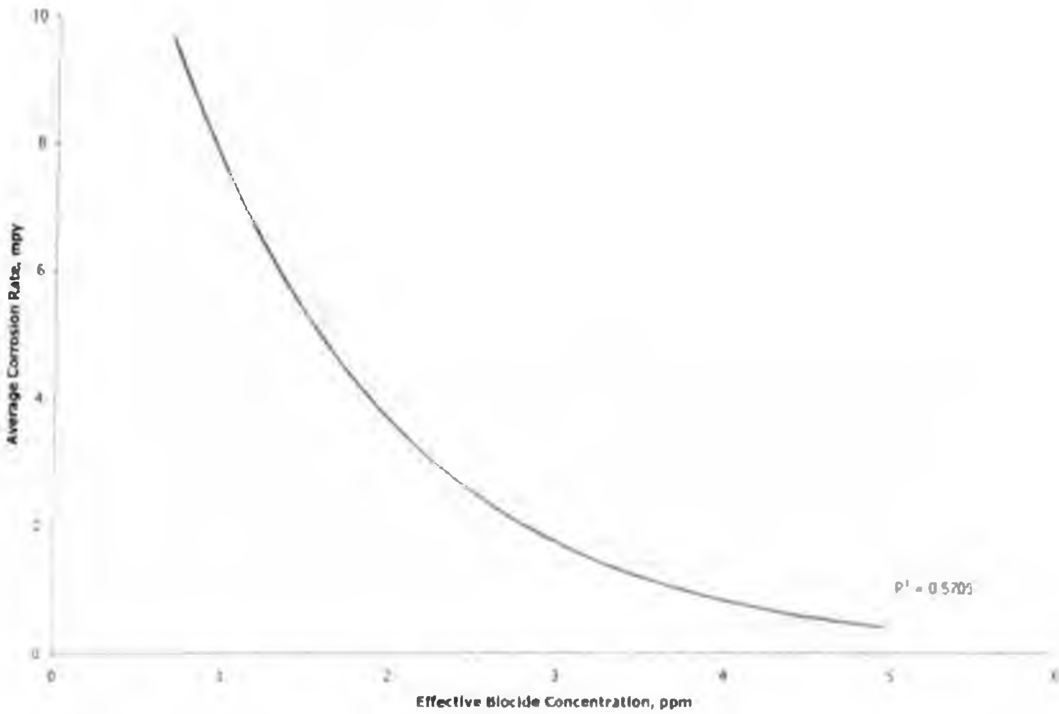
From	To	ppm	Interval days	Product
Jan-97	Jul-97	750	7	Glutaraldehyde
Jul-97	Feb-00	750	14	Glutaraldehyde
Feb-00	Aug-01	450	14	Glutaraldehyde/quaternary amine blend
Aug-01	Jul-02	500	14	Glutaraldehyde/quaternary amine blend
Jul-02	Dec-02	500	7	Glutaraldehyde/quaternary amine blend
Dec-02	Mar-03	500	7	Glutaraldehyde/quaternary amine blend
Mar-03	Dec-03	750	7	Glutaraldehyde/quaternary amine blend
Dec-03	Oct-04	750	7	Glutaraldehyde
Oct-04	Present	750	7	Glutaraldehyde/quaternary amine blend

GPB Table C.2 Biocide Treatment Concentration and Interval

The effect of increasing biocide on the corrosion rates in the SW system are more clearly shown in GPB Figure C.14, which shows the correlation between the average corrosion rate and effective biocide concentration for 2001 through 2004.



GPB Figure C.13 Biocide Treatment Concentration and Corrosion Rate



GPB Figure C.14 Average Corrosion Rate vs. Effective Concentration, 2001 - 2004

In summary, improvements made in DO control and increased biocide injection rate have reduce corrosion rates in the seawater system. The data suggest progress has been made in returning the seawater system to control, however as with the produced water system, caution is warranted. Therefore, there will be an on-going effort in 2005 to assure that this trend is confirmed and continued. Should a long-term trend of reduced corrosion rates not be established, then further corrective actions will be implemented.

Section C.3 Electrical Resistance Probes

ER probes are installed in various locations to monitor corrosion rates in flow lines throughout GPB. ER probes measure a change in resistance due to material loss from corrosion and the measurements are converted to provide corrosion rates in mils per year. ER probes are equipped with remote data collectors (RDC), which measure and record the metal loss data every 4 hours. This provides an adequate number of data points to assess corrosion rates while maximizing battery life in the units.

The type of ER probe used is a T-10 that has 5 mils (0.005") of usable metal thickness. All flow line ER probes are replaced based on a 1-year service life, or when one half the usable metal thickness has been consumed. This reduces false negative and false positive readings as a result of damaged or unresponsive probes.

ER probes are located on both the upstream (well pad) end and downstream (gathering center) end of flow lines located on the west side of GPB. On the east side, probes are only located on the downstream (flow station) end of flow lines.

For the electrical resistance (ER) probes, the number of active locations in the flow lines is given in GPB Table C.3. 2004 had the greatest number of ER probes in service which reflects an ongoing effort to utilize ER probe monitoring equipment on all large diameter oil service flow lines.

Year	Total Probe Locations
2001	83
2002	82
2003	85
2004	87

GPB Table C.3 Active ER Probe Locations

ER probe data are collected in the field and uploaded to the corrosion and inspection database once per week. The target for ER probe corrosion rate is ≤2 mpy. Each ER probe with a corrosion rate greater than 2 mpy is evaluated to determine data validity. After verifying an increase in corrosion rates based on the probe data and other supporting data, an action is determined. The action is typically a corrosion inhibitor increase, but other sorts of mitigation may be recommended.

GPB Table C.4 shows the number of probes with corrosion rates greater than target as compared to the number actioned dating back to 2001.

Year	% <2 mpy	No. ER Probe > 2	No. ER Probes Actioned
2001	97%	193	6
2002	97%	137	6
2003	96%[6]	138	21
2004	92%	316	59

GPB Table C.4 Number of ER Probes >2 mpy and Actioned

The 59 occurrences greater than 2 mpy in 2004 were mitigated with corrosion inhibitor rate increases. The percentage of ER probes actioned has increased from 2% in 2001 to 19% in 2004. This increase is the result of emphasis on ER probe reliability and a more conservative approach responding to monitoring data.

Section H.1.5 shows the corrective mitigation actions taken as a result of ER probe readings exceeding target and Appendix 3.3.1 describes by example, the methodology

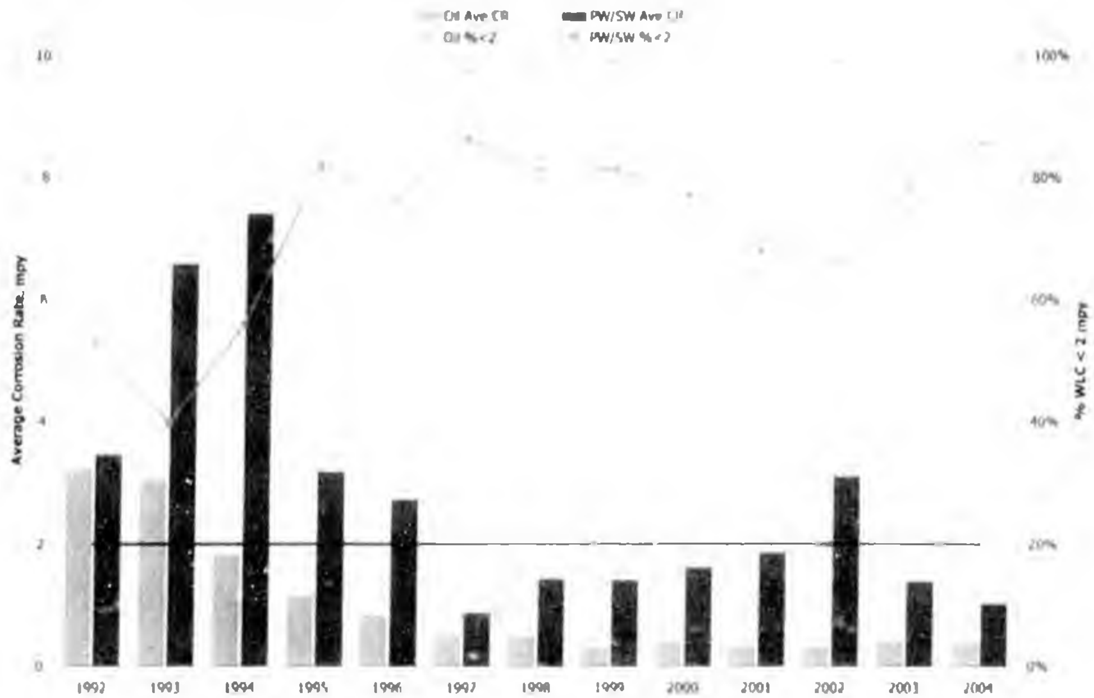
[6] Incorrectly reported as 93% in 2003 Report

by which corrosion inhibitor concentration is increased as a result of ER probes monitoring.

Section C.4 1992 to Date Summary

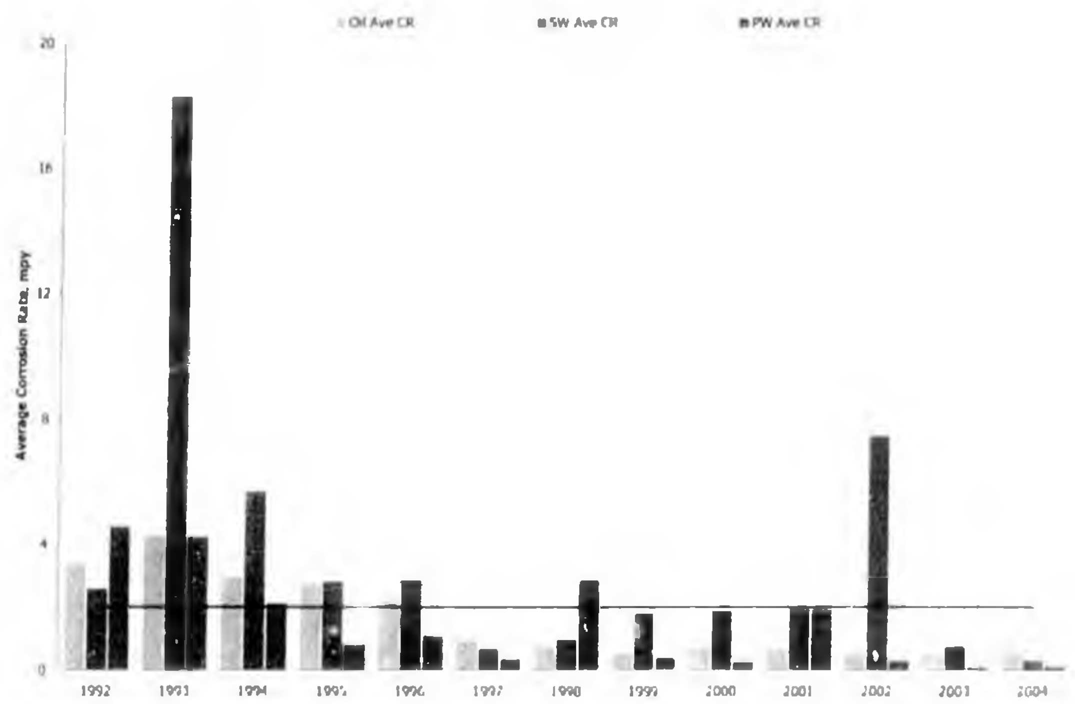
Section C.4.1 System by System Summary

This section provides system-by-system summary since 1992 for the major systems at GPB. GPB Figure C.15 shows the corrosion rate and corrosion target conformance since 1992. The high performance in the 3-phase production system has remained essentially unchanged since 2000. The reasons for improvement in the water injection system performance were provided in Section C.2.

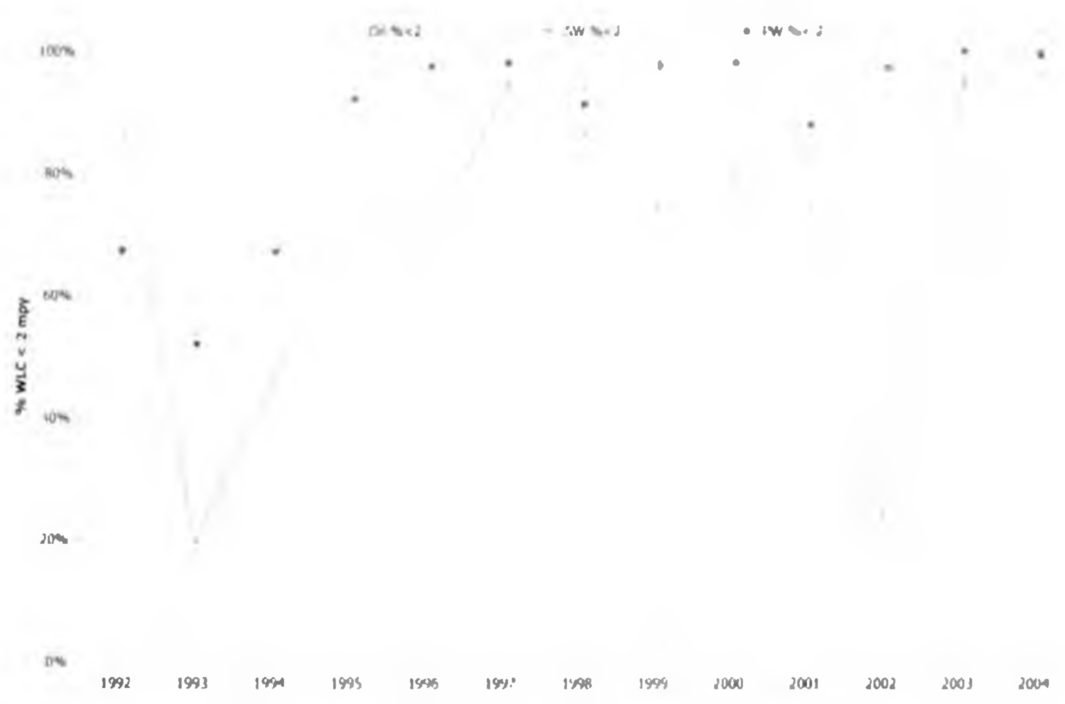


GPB Figure C.15 Flow Line Corrosion Coupon Summary by Equipment and Service

GPB Figure C.16 shows the corrosion rate and GPB Figure C.17 shows corrosion conformance for well lines. The well line 3-phase system performance has remained essentially unchanged since 2000. The produced water well lines corrosion performance has remained essentially consistent since 2002. The well lines in seawater service show additional improvement in performance.

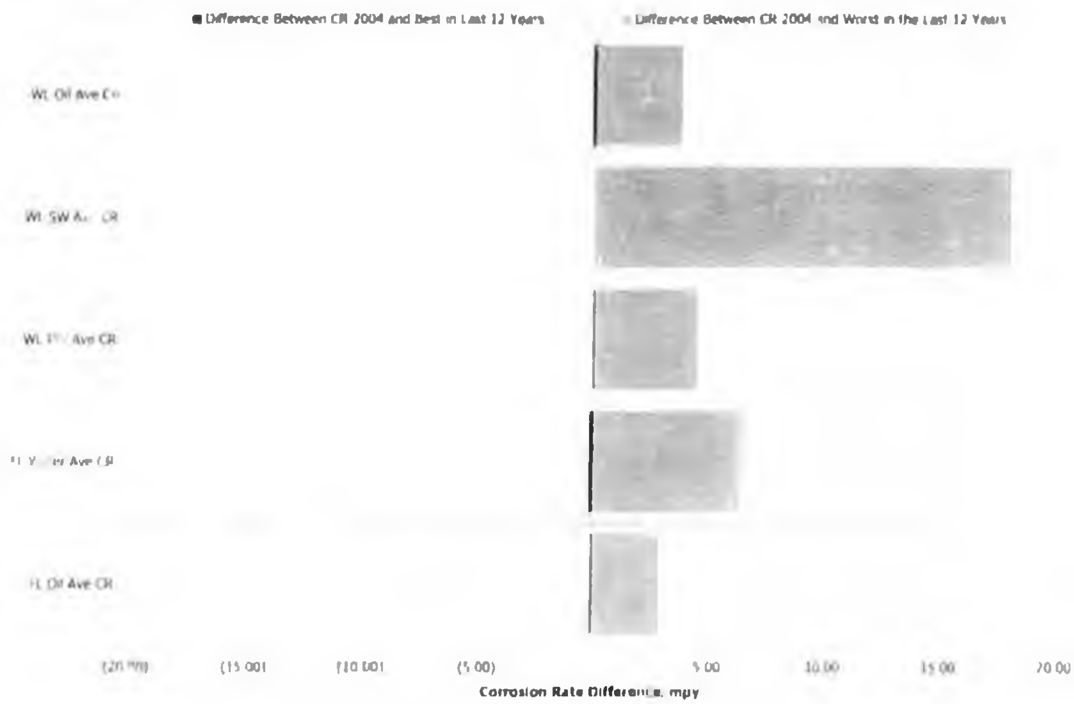


GPB Figure C.16 Well Line Average Corrosion Rate Summary by Equipment and Service



GPB Figure C.17 Well line %<2 mpy Summary by Equipment and Service

In order to assess the relative performance of the corrosion management program today versus that of the last 12 years, GPB Table C.5 and GPB Figure C.18 were generated as a summary. The data show the difference between the 2004 WLC corrosion rate for each of the systems and the best, or lowest, WLC corrosion rate and the worst, or highest, WLC corrosion rate observed since 1992. This is an approximate measure of the successes and/or shortcomings of the program today versus the ~12-year history and highlights areas for attention. The results indicate the current level of corrosion control, as determined by weight loss coupons, is at or near the best levels of control in the last 12 years for each system.



GPB Figure C.18 WLC Corrosion Rate Difference by Service and Type

System	2004 CR mpy	Best mpy	(Best – 2004) mpy	Worst mpy	(Worst – 2004) Mpy
FL Oil Ave CR	0.37	0.32	-0.05	3.2	2.86
FL Water Ave CR	1.02	0.87	-0.15	7.4	6.37
WL PW Ave CR	0.11	0.09	-0.02	4.6	4.47
WL SW Ave CR	0.30	0.30	0.00	18.2	17.94
WL Oil Ave CR	0.59	0.47	-0.12	4.3	3.70

GPB Table C.5 WLC Corrosion Rate Difference by Service and Type

In summary,

Well Line Oil Service – Significant improvements in performance occurred from 1992 to 1997 when the average corrosion rate (CR) was reduced from 3.6 to 1.0 mpy (~70%

improvement) and conformance to the 2 mpy target was increased from 64% to 88% (~40% improvement). Since then, average CR has been <1 mpy, and target conformance performance has been >90%. In 2004, values were 0.6 mpy and 94% respectively.

Flow Line Oil Service – Significant improvements in performance occurred from 1992 to 1997 when the average CR was reduced from 3.3 to 0.5 mpy (~85% improvement) and conformance to the 2 mpy target was increased from 77 to 97% (~25% improvement). Since then, CR and target conformance performance has improved. The 2004 CR and target conformance performance were 0.4 mpy and 98%, respectively.

Flow Line Processed Oil – These are the flow lines supplying processed hydrocarbon to Pump Station 1 and as might be expected for a very low water cut production stream, the corrosion rates are consistently very low with 100% of the coupons being reported as less than 2 mpy from 1995 to 2004.

Well Line PW Service – Average CR and percent conformance with the 2 mpy target was just under the historical best performance, with 0.1 mpy and 99%. The two excursions, 1998 and 2001, were likely the result of reduced system velocities and oil system corrosion inhibitor changes. Work continues in the evaluation of new corrosion control techniques designed specifically for the PW system.

Well Line SW Service – Performance deteriorated from 1997 through 2002 with the average CR increased from 0.7 to 7.5 mpy. Average CR and percent conformance with the 2 mpy target rebounded in 2003 to 0.7 mpy and 95% respectively. For the 100% SW service, this trend continued in 2004, with an average CR of 0.3 mpy and percent conformance of 100% <2 mpy. For the Majority SW service, there was a decline in 2004 with 1.4 mpy and 85% <2 mpy. This decline is believed to be due to the service change between SW and PW.

Flow Line PW/SW Service – Performance deteriorated from 1992 to 1994 when average CR increased from 3.5 to 7.4 mpy. However, significant improvements occurred from 1994 to 1997 when the average CR was reduced to 0.8 mpy. Since then, CR and target conformance degraded until 2003 when performance improved to 1.4 mpy and 78% respectively. The improved performance continued in 2004 with the CR and target conformance performance at 1.0 mpy and 86%, respectively..

BU	Equip	Service	Metric	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
GPB	FL	OIL	WLC	782	949	972	1,397	1,542	1,597	1,487	1,513	1,443	1,294	1,338	1,321	1,236
GPB	FL	OIL	Ave CR	3.23	3.05	1.82	1.17	0.84	0.47	0.49	0.32	0.42	0.34	0.33	0.42	0.37
GPB	FL	OIL	SD CR	8.64	10.41	5.13	5.37	3.95	1.82	3.77	0.57	0.84	0.90	0.67	2.39	0.99
GPB	FL	OIL	WLC < 2	604	733	841	1,270	1,460	1,552	1,458	1,499	1,403	1,273	1,325	1,315	1216
GPB	FL	OIL	% WLC < 2mpy	77%	77%	87%	91%	95%	97%	98%	99%	97%	98%	99%	100%	98%
GPB	FL	PW/SW	WLC	81	106	154	198	184	195	171	181	161	131	137	144	112
GPB	FL	PW/SW	Ave CR	3.45	6.58	7.40	3.18	2.73	0.87	1.44	1.41	1.61	1.86	3.11	1.39	1.02
GPB	FL	PW/SW	SD CR	4.43	9.13	15.37	9.52	6.15	1.77	3.72	2.42	2.77	2.54	5.39	2.52	1.46
GPB	FL	PW/SW	WLC < 2	43	42	86	162	140	168	139	147	124	89	90	113	96
GPB	FL	PW/SW	%<2mpy	53%	40%	56%	82%	76%	86%	81%	81%	77%	68%	66%	78%	86%
GPB	FL	PO	WLC		16	23	24	34	44	32	34	36	22	28	44	36
GPB	FL	PO	Ave CR		0.43	0.56	0.13	0.23	0.13	0.16	0.14	0.17	0.08	0.09	0.11	0.10
GPB	FL	PO	SD CR		0.41	0.39	0.17	0.29	0.19	0.11	0.05	0.07	0.06	0.03	0.04	0.05
GPB	FL	PO	WLC < 2		16	23	24	34	44	32	34	36	22	28	44	36
GPB	FL	PO	%< 2 mpy		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
GPB	WL	OIL	WLC	6,826	5,660	4,997	5,277	6,607	6,821	6,449	6,219	6,265	4,889	5,327	5,568	5,087
GPB	WL	OIL	Ave CR	3.42	4.29	2.93	2.72	2.21	0.92	0.72	0.54	0.74	0.64	0.58	0.47	0.59
GPB	WL	OIL	SD CR	7.81	8.05	4.51	6.96	6.18	2.33	3.69	1.20	1.49	1.60	1.12	1.15	1.43
GPB	WL	OIL	WLC < 2	4,537	3,055	2,873	3,769	5,055	6,062	6,065	5,979	5,791	4,564	4,989	5,347	4773
GPB	WL	OIL	%< 2 mpy	66%	54%	57%	[illegible]	77%	89%	94%	96%	92%	93%	94%	96%	94%
GPB	WL	Majority PW	WLC	531	514	662	829	976	1,073	966	740	699	659	464	430	374
GPB	WL	Majority PW	Ave CR	5.82	3.46	1.91	0.80	0.86	0.35	2.44	0.47	0.27	1.43	0.29	0.09	0.15
GPB	WL	Majority PW	SD CR	12.84	4.81	1.92	1.19	8.68	2.26	12.05	1.64	0.43	8.55	0.88	0.13	0.41
GPB	WL	Majority PW	WLC < 2	345	307	467	760	947	1,047	886	716	690	598	449	430	367
GPB	WL	Majority PW	% WLC <2 mpy	65%	60%	71%	92%	97%	98%	92%	97%	99%	91%	97%	100%	98%
GPB	WL	100% PW	WLC	282	304	286	485	604	717	721	524	459	473	332	358	302
GPB	WL	100% PW	Ave CR	4.58	4.24	2.12	0.81	1.10	0.35	2.90	0.40	0.30	1.92	0.29	0.09	0.11
GPB	WL	100% PW	SD CR	[illegible]	5.34	2.05	1.19	10.98	2.62	13.64	1.50	0.51	10.05	0.97	0.13	0.28
GPB	WL	100% PW	WLC < 2	190	158	192	447	539	703	658	512	450	416	323	358	300
GPB	WL	100% PW	% WLC < 2mpy	67%	52%	67%	92%	98%	98%	91%	98%	98%	88%	97%	100%	99%
GPB	WL	Majority SW	WLC	434	410	384	317	162	56	44	82	98	44	25	19	26
GPB	WL	Majority SW	Ave CR	1.97	13.02	6.52	2.63	3.25	0.65	0.96	1.82	1.78	6.01	6.58	0.74	1.41
GPB	WL	Majority SW	SD CR	5.48	16.14	7.55	3.86	5.26	1.20	1.14	2.36	2.77	6.88	5.27	0.68	2.87
GPB	WL	Majority SW	WLC < 2	382	103	135	203	110	53	38	61	78	16	7	18	22
GPB	WL	Majority SW	% WLC < 2mpy	88%	25%	35%	64%	68%	95%	86%	74%	80%	36%	28%	95%	85%
GPB	WL	100% SW	WLC	184	194	176	189	78	52	44	70	86	16	21	19	12
GPB	WL	100% SW	Ave CR	2.59	18.24	5.68	2.80	2.86	0.68	0.96	1.82	1.89	1.92	7.46	0.74	0.30
GPB	WL	100% SW	SD CR	7.13	19.04	8.04	4.43	5.39	1.24	1.14	2.50	2.93	1.07	5.28	0.68	0.27
GPB	WL	100% SW	WLC < 2	160	38	81	130	54	49	38	52	68	12	5	18	12
GPB	WL	100% SW	% WLC < 2mpy	87%	20%	46%	69%	69%	94%	86%	74%	79%	75%	24%	95%	100%

GPB Table C.6 Flow and Well Line General Corrosion Rate Data Summary

BU	Equip	Service	Metric	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
GPB	FL	OIL	WLC	782	949	972	1,397	1,542	1,597	1,487	1,513	1,443	1,294	1,338	1,321	1,236
GPB	FL	OIL	Ave P CR	7.0	5.5	4.1	8.81	7.71	6.74	2.93	1.65	1.93	1.28	0.74	0.65	1.2
GPB	FL	OIL	SD P CR	21.9	14.8	13.2	21.95	14.92	13.88	6.67	6.17	7.73	10.59	3.93	8.32	5.9
GPB	FL	OIL	P WLC < 20	688	869	923	1,280	1,448	1,542	1,461	1,490	1,410	1,279	1,317	1,319	1,221
GPB	FL	OIL	% P WLC <20mpy	88%	92%	95%	92%	94%	97%	98%	98%	98%	99%	98%	100%	99%
GPB	FL	PW/SW	WLC	81	106	154	198	184	195	171	181	161	131	137	144	112
GPB	FL	PW/SW	Ave P CR	8.5	15.8	17.3	17.03	14.40	15.26	11.36	5.31	6.47	9.37	13.12	7.07	3.7
GPB	FL	PW/SW	SD P CR	8.5	5.4	8.6	6.60	5.40	4.10	3.01	2.53	2.32	0.91	0.01	0.01	0.0
GPB	FL	PW/SW	P WLC < 20	80	97	140	190	178	195	170	181	161	131	134	144	112
GPB	FL	PW/SW	% P WLC <20mpy	99%	92%	91%	96%	97%	100%	99%	100%	100%	100%	98%	100%	100%
GPB	FL	PO	WLC		16	23	24	34	44	32	34	36	22	28	44	36
GPB	FL	PO	Ave P CR		0.5	0.7	1.88	2.56	3.73	2.19	1.26	1.44	1.05	0.77	0.32	0.7
GPB	FL	PO	SD P CR		1.2	2.5	3.42	4.64	4.31	5.65	2.43	3.49	3.47	3.92	2.11	2.9
GPB	FL	PO	P WLC < 20		16	23	24	34	44	31	34	36	22	26	44	36
GPB	FL	PO	% P WLC <20mpy		100%	100%	100%	100%	100%	97%	100%	100%	100%	93%	100%	100%
GPB	WL	OIL	WLC	6,826	5,660	4,997	5,277	6,607	6,821	6,449	6,219	6,265	4,889	5,327	5,568	5,087
GPB	WL	OIL	Ave P CR	7.3	9.4	5.2	11.37	11.71	5.24	3.24	2.76	3.28	1.97	1.71	1.66	2.0
GPB	WL	OIL	SD P CR	22.4	24.7	14.3	31.31	28.93	14.67	10.08	7.80	10.16	6.43	5.61	5.33	5.9
GPB	WL	OIL	P WLC < 20	5,397	4,998	4,660	4,619	5,739	6,540	6,285	6,094	6,078	4,784	5,251	5,518	4,991
GPB	WL	OIL	% P WLC <20mpy	86%	88%	93%	88%	87%	96%	97%	98%	97%	98%	99%	99%	98%
GPB	WL	Majority PW	WLC	531	514	662	829	976	1073	966	740	699	659	464	430	374
GPB	WL	Majority PW	Ave P CR	34.1	24.7	15.8	20.18	15.02	9.65	20.65	8.87	4.65	6.69	2.95	1.08	2.3
GPB	WL	Majority PW	SD P CR	41.1	31.9	27.1	29.05	29.64	28.96	58.54	26.07	9.75	17.52	8.97	3.01	9.4
GPB	WL	Majority PW	P WLC < 20	258	294	499	574	802	968	807	674	670	579	452	429	369
GPB	WL	Majority PW	% P WLC < 20mpy	49%	57%	75%	69%	82%	90%	84%	91%	96%	88%	97%	100%	99%
GPB	WL	100% PW	WLC	282	304	286	485	604	717	721	524	459	473	332	358	302
GPB	WL	100% PW	Ave P CR	4.6	4.2	2.1	0.81	1.10	0.35	2.90	0.40	0.30	1.92	0.29	0.09	0.1
GPB	WL	100% PW	SD P CR	9.3	5.3	2.0	1.19	10.98	2.62	13.64	1.50	0.51	10.05	0.97	0.13	0.3
GPB	WL	100% PW	WLC < 20	190	158	192	447	589	703	658	512	450	416	323	358	300
GPB	WL	100% PW	% P WLC <20mpy	67%	52%	67%	92%	98%	98%	91%	98%	98%	88%	97%	100%	99%
GPB	WL	Majority SW	WLC	434	410	384	317	162	56	44	82	98	44	25	19	26
GPB	WL	Majority SW	Ave P CR	4.7	17.3	9.5	11.36	16.88	1.50	1.55	5.62	6.61	18.80	29.33	9.11	9.1
GPB	WL	Majority SW	SD P CR	15.6	44.3	14.2	15.43	23.11	4.52	2.31	8.16	10.40	18.59	27.35	20.21	16.0
GPB	WL	Majority SW	P WLC < 20	404	320	331	263	115	55	44	80	92	24	15	16	23
GPB	WL	Majority SW	% P WLC < 20mpy	93%	78%	86%	83%	71%	98%	100%	98%	94%	55%	60%	84%	88%
GPB	WL	100% SW	WLC	184	194	176	189	78	52	44	70	86	16	21	19	12
GPB	WL	100% SW	Ave P CR	5.2	13.3	7.8	9.09	10.10	0.54	1.55	5.24	5.57	9.13	31.62	9.11	9.2
GPB	WL	100% SW	SD P CR	18.9	18.8	12.1	13.41	19.87	2.19	2.31	8.49	6.38	7.30	29.49	20.21	21.4
GPB	WL	100% SW	P WLC < 20	172	157	156	162	62	52	44	68	82	14	12	16	10
GPB	WL	100% SW	% P WLC <20mpy	93%	81%	89%	86%	79%	100%	100%	97%	95%	88%	57%	84%	83%

GPB Table C.7 Flow and Well Line Pitting Rate Data Summary

Section D

Chemical Optimization Activities

Section D Chemical Optimization Activities

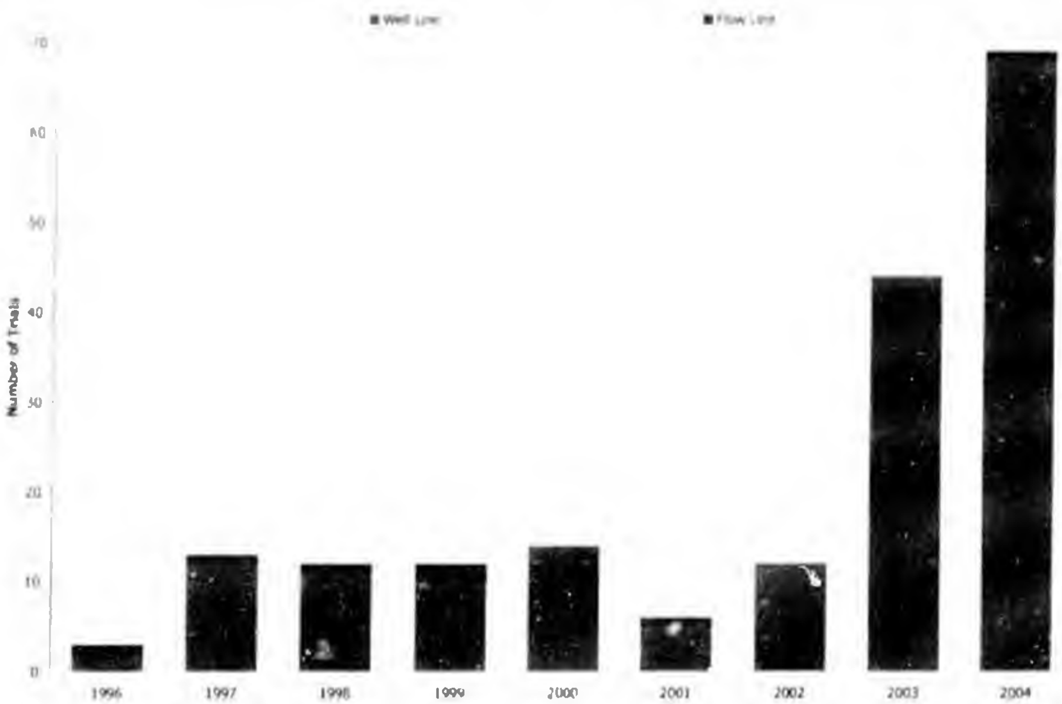
Section D.1 Chemical Optimization

Chemical optimization is an on-going process that encompasses a broad range of activities, from developing new corrosion inhibitors for improved performance, to the allocation of extra chemical for additional corrosion control. The following sections provide an update on chemical development, field wide chemical deployment, chemical usage and finally corrosion control.

Section D.2 Corrosion Inhibitor Testing

GPB Figure D.1 summarizes the number of well line and flow line tests which have been completed since 1996. The level of well line test activity increased during 2003 and 2004 due to a change in the screening protocol, which reduced the time required per test. The combined number of well line and flow line tests has increased from ~10-14 per year to more than 65 during 2004.

The data prior to 2000 are incomplete and represents the test work completed on the heritage WOA only. This level of activity represents a substantial investment of resources towards the development of new and more effective corrosion inhibitors.



GPB Figure D.1 Number of Well Line and Flow line Tests

One test chemical was advanced from the well line test program to large scale flow line testing. While this test chemical was an effective corrosion inhibitor, it was not compatible with the stainless steel delivery system. The test was concluded after ~120 days with no plans to pursue that particular chemistry.

Section D.3 Field Wide Corrosion Inhibitor Deployment

The chemical development and testing program has been highly successful in recent years, with 18 new products being developed for use in the continuous wellhead inhibition program since 1995. All these changes over the last 9 years represent a significant improvement in overall corrosion control performance.

GPB Table D.1 summarizes the changes in corrosion inhibitor products since 1995. The table does not include test products which did not make it to field wide usage. In addition, the summary table does not include summer versions of products that differ only in pour point from the winter version shown in the table.

Supplier	Chemical	95	96	97	98	99	00	01	02	03	04
Nalco Exxon	EC1110A	■	■								
Nalco Exxon	EC1259			■	■						
Nalco Exxon	97VD129				■	■	■				
Nalco Exxon	98VD118				■	■	■	■			
ONDEO Nalco	99VD049					■	■	■			
ONDEO Nalco	01VD017							■			
ONDEO Nalco	01VD121							■	■	■	■
Nalco	DVE4D002										■
Champion	RU205	■									
Champion	RU210	■	■	■							
Champion	RU223	■	■	■	■						
Champion	RU258			■							
Champion	RU271				■	■	■				
Champion	RU126A						■				
Champion	RU256[1]			■	■	■	■	■	■	■	■
Champion	2004-15[1]										■

[1]Used for the batch treatment of well lines while the remaining chemicals are all used for continuous application

GPB Table D.1 Summary of the Chemical Deployment History

Section D.4 Corrosion Inhibitor Usage and Concentration

Another measure of chemical optimization is the amount of corrosion inhibitor used relative to the volume of water produced from the reservoir. GPB Table D.2 summarizes the annual water production, corrosion inhibitor volumes, and concentrations since 1995. The inhibitor volumes are expressed as a 'winter product equivalent', i.e. the lower volumes of highly concentrated chemical used during the summer have been normalized to the winter equivalent.

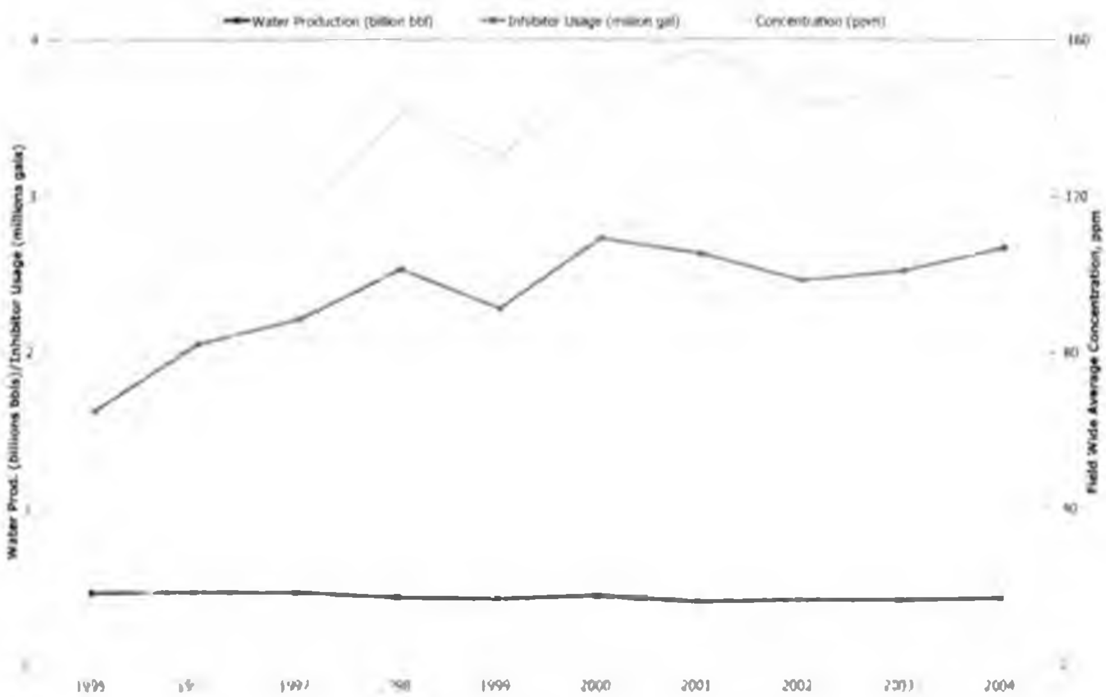
The concentration of inhibitor in the water phase provides a relative measure of the effectiveness of the chemical used to control corrosion. However, such data can be misleading as the types of corrosion inhibitors used can vary from year to year (GPB Table D.1). As more effective chemicals are developed, volumes and concentrations will change depending on the individual product's performance characteristics. There has also been a shift from batch treatments to continuous injection of chemical at the wellhead. The latter is more efficient in terms of protection achieved per gallon of chemical and therefore lower chemical usage would be expected. However, the ultimate measure of whether or not enough corrosion inhibitor is used can only be determined by consideration of other factors such as corrosion monitoring data and/or the amount of active corrosion detected by the inspection program.

Year	H_2O Production 10^6 bbl/yr	Water Cut %	CI Usage 10^6 gal/yr	CI Concentration ppm
1995	455	59	1.62	85
1996	460	62	2.05	106
1997	457	62	2.21	115
1998	426	66	2.53	141
1999	416	68	2.28	130
2000	438	70	2.73	148
2001	398	70	2.63	157
2002	407	71	2.45	143
2003	408	72	2.52	147
2004	422	74	2.67	151

GPB Table D.2 Summary of the Chemical Usage History

The advances in the development of more effective corrosion inhibitors is counteracted by the increasing water cuts associated with an aging oil field and increased flow velocities due to increased gas rates. These changes generally increase the amount of chemical required to control corrosion. As GPB Figure D.2 shows, the volume of corrosion inhibitor has increased since 1995 while the water volumes have remained relatively constant.

The metrics in GPB Figure D.2 deal with chemical usage at the field level but much of the chemical optimization activity focuses on injecting the correct amount of corrosion inhibitor to each piece of equipment. The inhibitor requirement is driven by factors such as water cut, water volume, flow regime, and condition of the equipment and varies over a wide range, from a few parts per million (ppm) to several hundred ppm. For 2004 the target chemical usage was 2.71 million gallons as compared to actual usage of 2.67 million gallons; or 98.5% of the target volume.



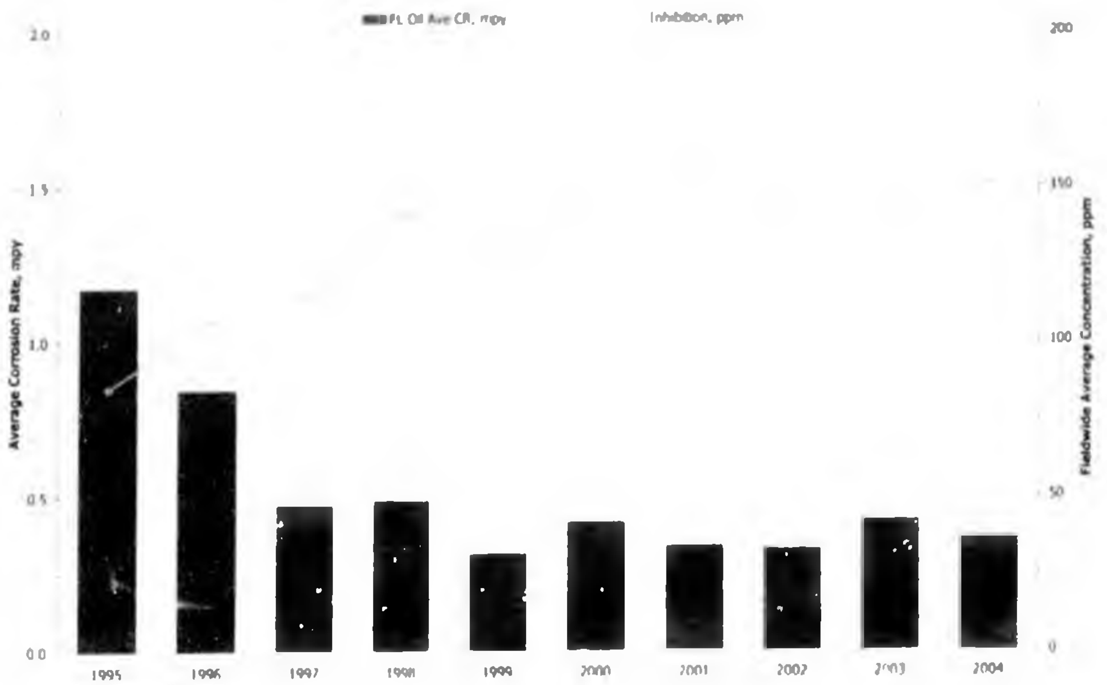
GPB Figure D.2 Field Wide Chemical Usage

Section D.5 Corrosion Inhibition and Corrosion Rate Correlation

As discussed in Section C.1, the reduction in corrosion rates in the 3-phase production system flow lines and well lines are largely attributable to the implementation of an aggressive corrosion inhibition program across GPB.

GPB Figure D.3 shows the correlation between the increased level of corrosion inhibitor and the reduction in average corrosion rate from 1995. As might be expected, the decline in average corrosion rate correlates with the increase in corrosion inhibition levels over time. The inhibition levels have increased ~80% from 1995 to 2004, with a field-wide average concentration of 85 ppm to 151 ppm. As a result the corrosion rates have fallen from 1.4 mpy in 1995 to ~0.4 mpy in 2004.

GPB Figure D.4 shows the annual field-wide average corrosion inhibitor concentrations versus annual average corrosion rates for 3-phase production flow lines. The figure shows how additional corrosion inhibitor has reduced the average corrosion rate through time, but also shows an inherent limitation of corrosion inhibition as the minimum corrosion rate (or maximum corrosion inhibitor efficiency) is approaching an asymptote of ~0.25 mpy.



GPB Figure D.3 Average Corrosion Rate Versus Inhibitor Concentration

GPB Figure D.4 Corrosion Inhibitor Concentration vs. Average Corrosion Rate