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Implementing a Well Integrity Management System

Joe Anders, P.E., SPE
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Prepared for the SPE Distinguished Lecturer Program
Revised: 17 March 2008

Objectives

- Why is Well Integrity important
- Components of a Well Integrity Management System

Topics

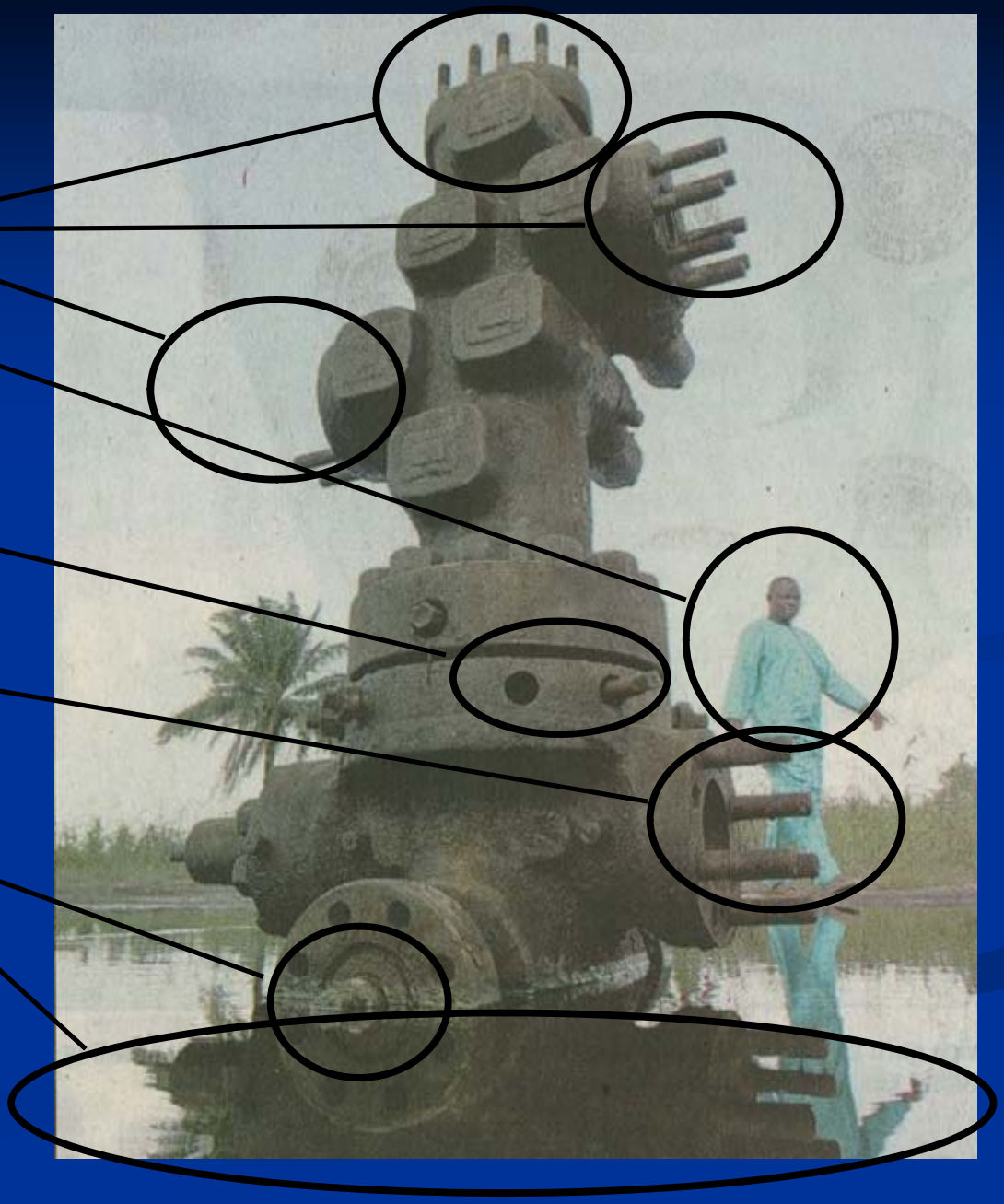
- Environmental & Safety Moments
- Define Well Integrity
- Failure Case History
- Components of a Well Integrity System
- Data Management
- Underground Failure Case Histories
- Program Checklist

Reference Material:

www.wellintegrity.net

Any issues with this well?

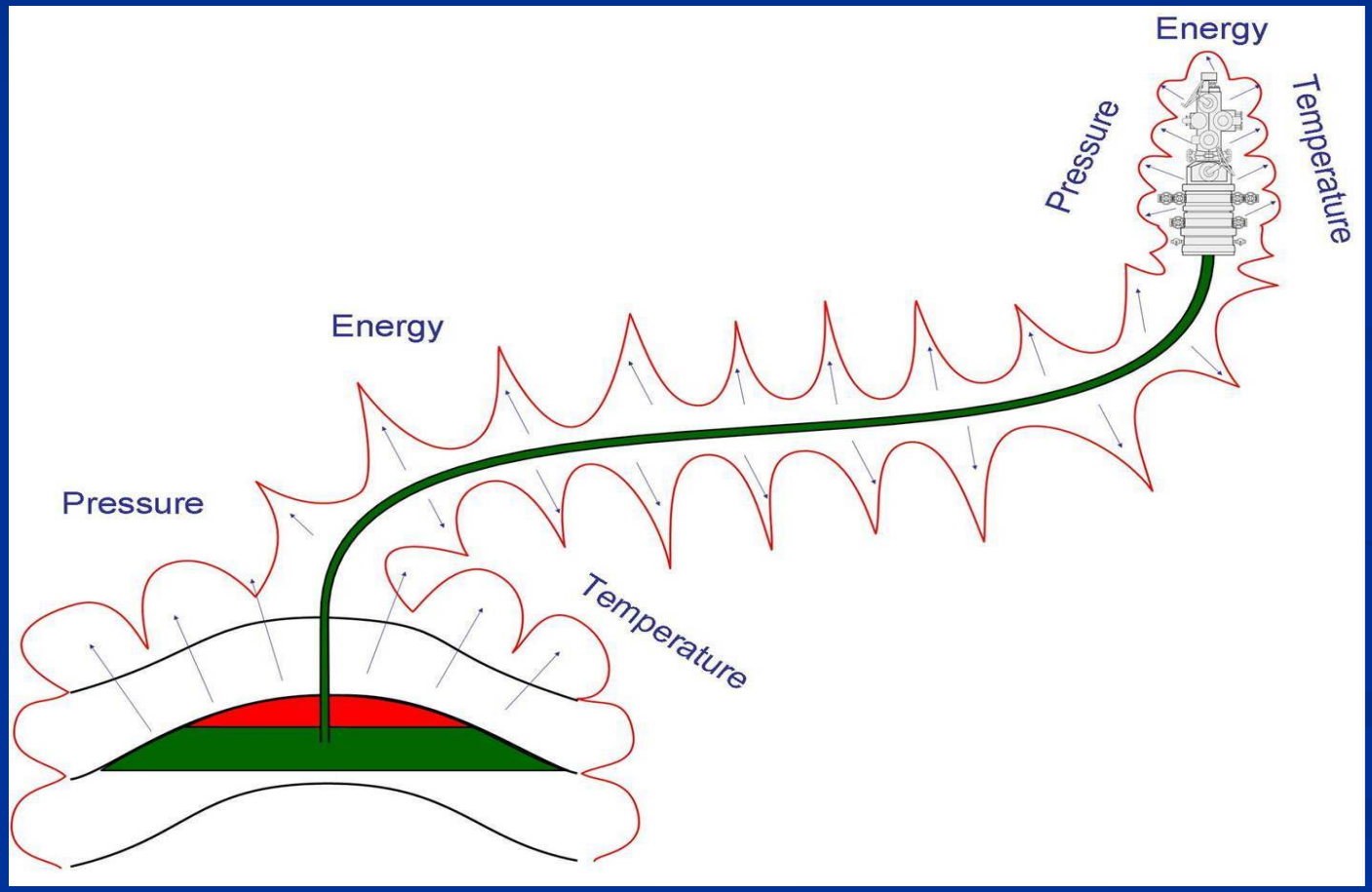
- Missing tree valves
- Located in populated area?
- Missing lockdown screws
- Missing annulus valves
- Exposed VR plug
- Marsh environment?
- **Who is accountable for this well?**



Anchorage Daily News, 17 June 2007, “Flawed Democracy”

Definition of Well Integrity

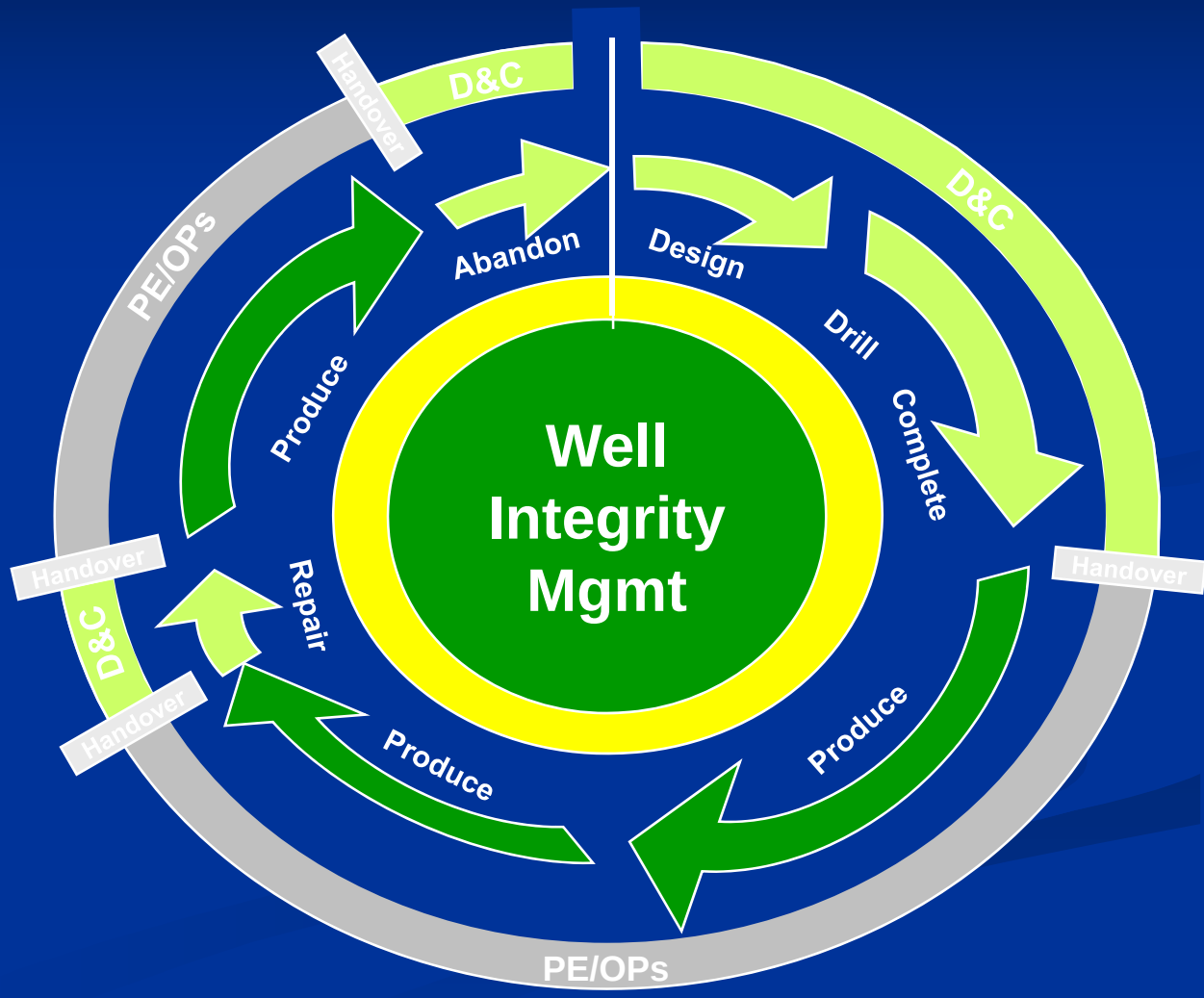
"Application of technical, operational and organizational solutions to reduce risk of uncontrolled release of formation fluids throughout the life cycle of a well" (NORSOK D-010)



SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

Well Integrity Life Cycle

- ✓ Design
- ✓ Construct
- ✓ Operate
- ✓ Maintain
- ✓ Abandon



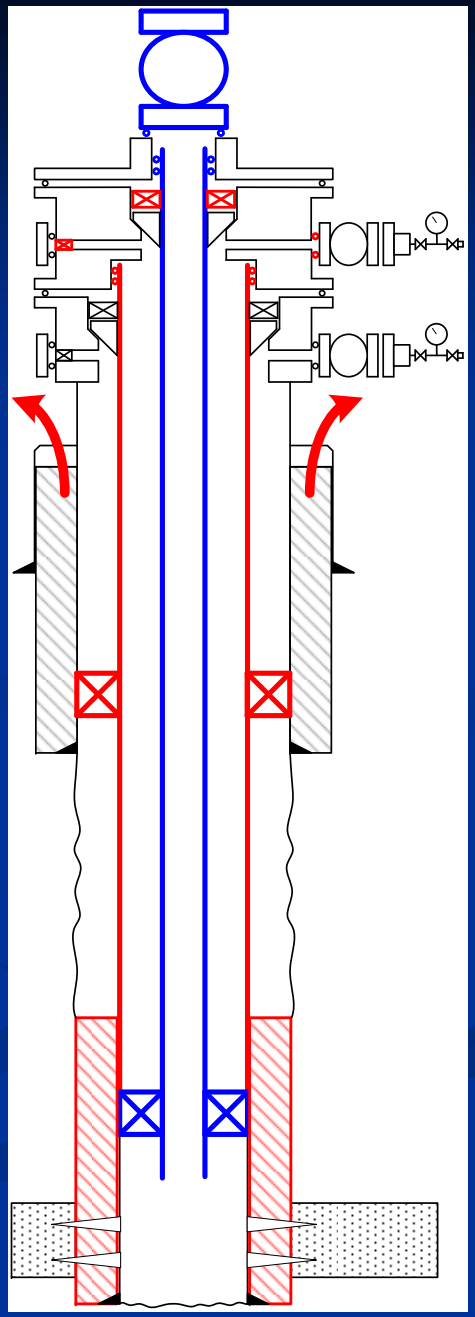
SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

Bomber Glacier, Alaska

- 50,000 U.S. traffic related fatalities, 130/day
- ~1 airplane/day – **would you fly?**
- **How does the aviation industry safely fly?**

Failure Case History Prudhoe Bay Well A-22

- B annulus pressure increased pressure to 7700 psi during startup
- Surface casing failed at 16 feet
- High pressure fluid flowed up conductor annulus



AOGCC report: "Investigation of Explosion and Fire at Prudhoe Bay Well A-22".

A-22 Surface Casing Failure

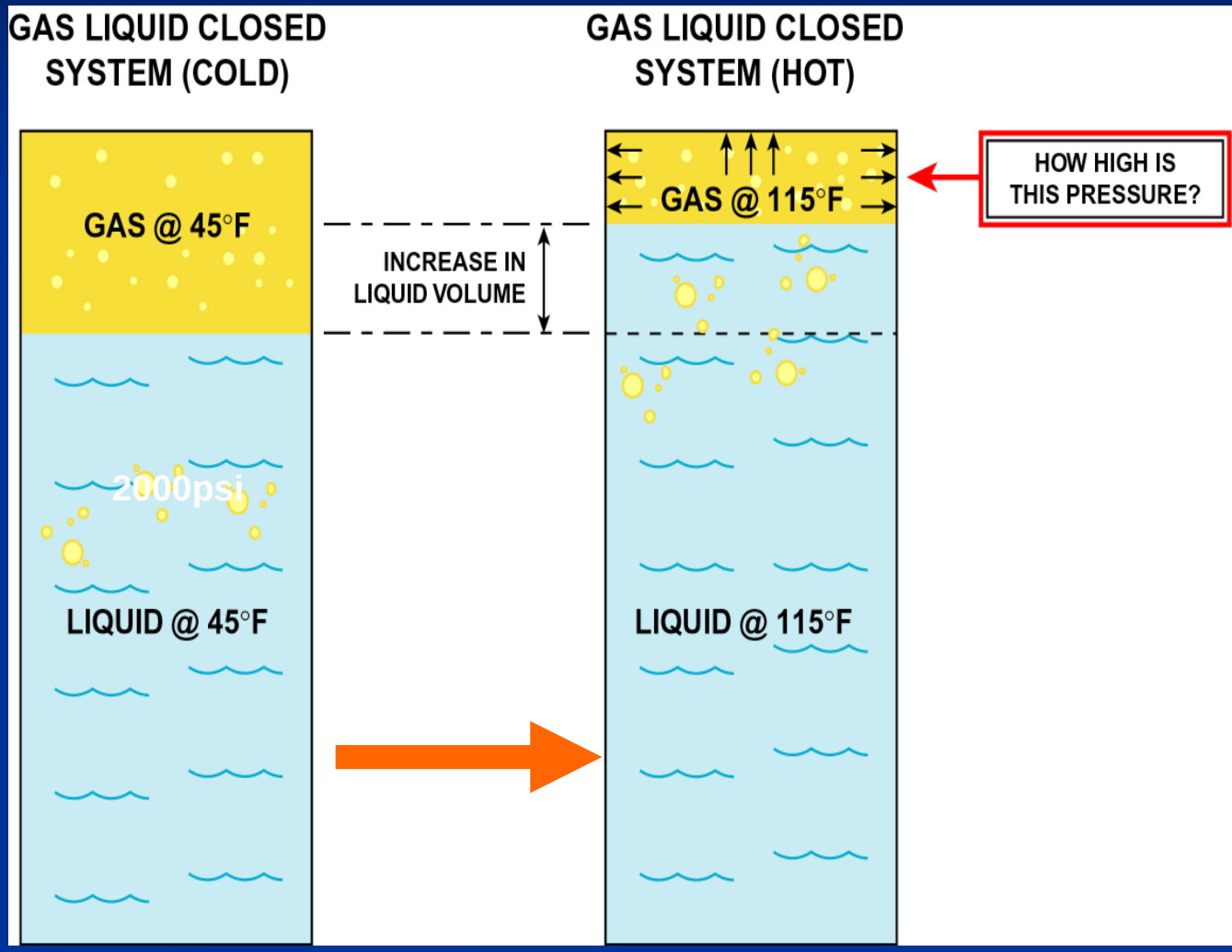
- Flooring timbers knocked off A annulus needle valve
- 2000 psi gas lift gas vented inside the wellhouse
- Gas ignited
- The Pad Operator was injured by the blast

AOGCC report: "Investigation of Explosion and Fire at Prudhoe Bay Well A-22".

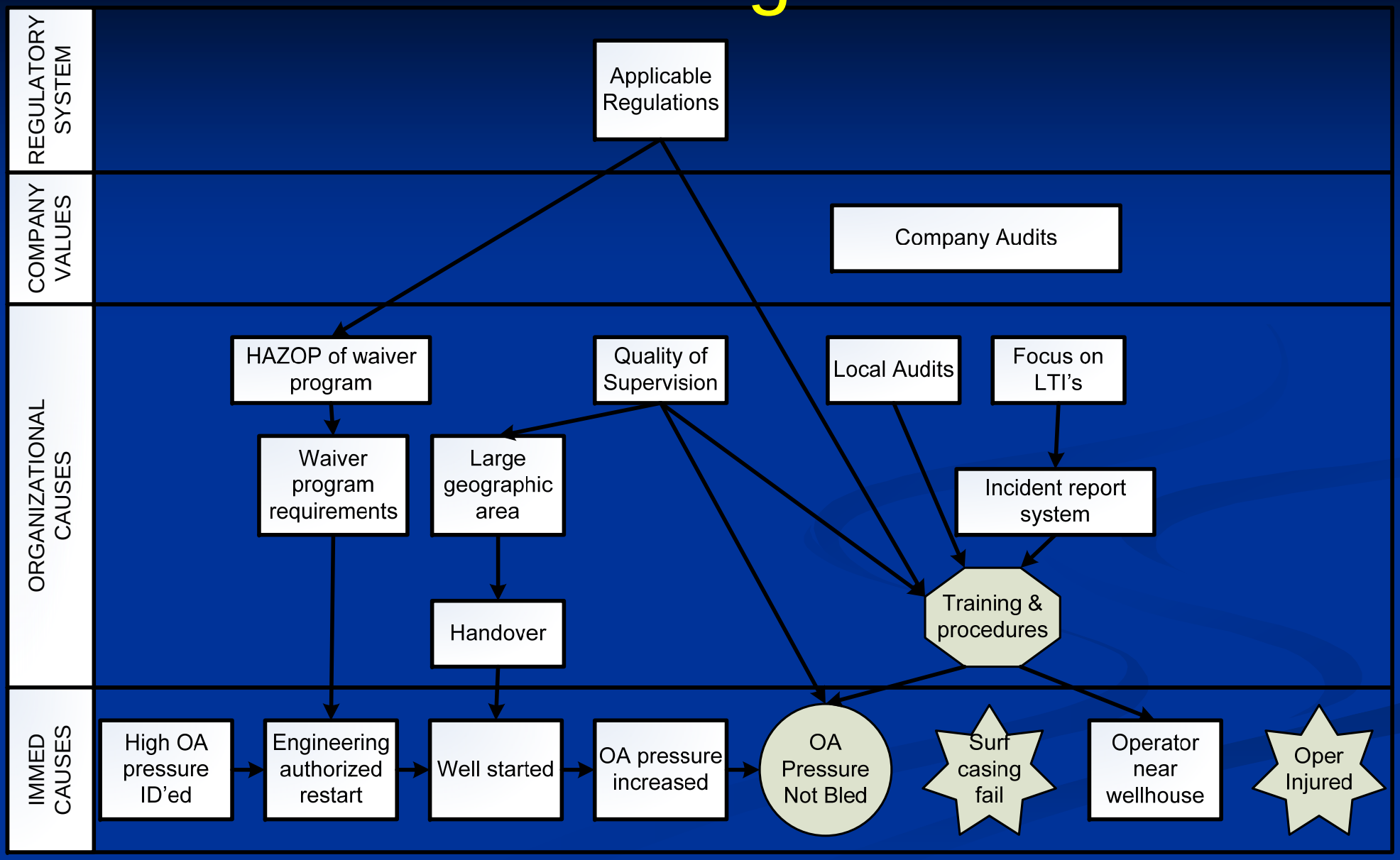
A-22 Annulus Pressure Build Up

- Starting B annulus pressure = 2000 psi
- Diesel in annulus
- Temperature rises 45F to 115F

Final Pressure = 7,700 psi



Causal Diagram



"Lessons from Longford", Andrews Hopkins, April 2000

Causal Factors

- Operator training, awareness of potential for annulus pressure buildup
- Startup procedures
- Reporting system for anomalies
- Risk assessment of operating with 2000 psi B annulus pressure
- Amount of responsibility
- Audit processes
- Accountability

Well Integrity Management System

1) Accountability & Responsibility
2) Well Operations
3) Well Interventions
4) Tubing / Annulus Program
5) Wellhead / Tree Maintenance
6) Safety Valve Program

SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

1) Accountability / Responsibility

Accountable

Makes sure it's done, <u>controls the resources</u>

Responsible

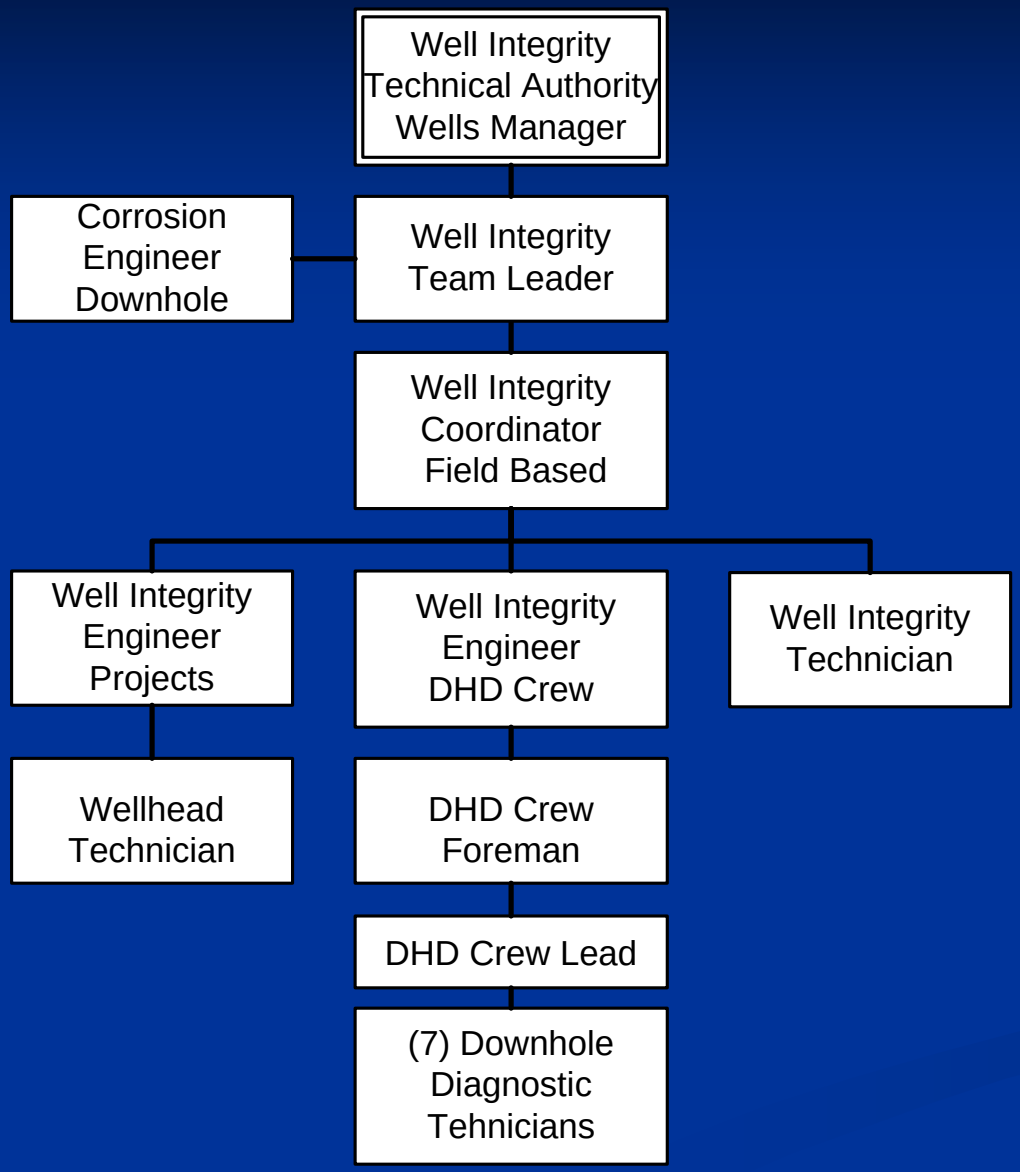
Does the work

Team approach, involving engineering, drilling, operations, regulators

Decisions/Functions	Functional Roles													
Well Integrity RACI Chart	Performance Unit Leader	Delivery Manager	Area Manager	Well Operations Supv.	Well Operations Coord.	Lead Operator	Field Operator		Wells Manager	Wireline Coord.	Well Integrity Coord.	Wells PE	GPB Staff Supt	Anch PE
Element 1: Accountability														
Overall Responsibility for implementation of the Well Integrity program														
Ensure Functional Roles know their RACI status			R											
Maintain the RACI Chart.			A	C	C	C	C		C	C	R	C	C	C
Initiate updates to the WI System Policy														
Maintain data systems necessary to support WI work processes.														
Initiate Peer Assists, Audits, etc. to ensure all the tasks on this RACI chart are being conducted.														
Ensure adequate resources are available to fulfill the RACI chart requirements.														
Element 2: Well Operating Procedures														
Ensure all personnel involved in well operations are competent.														
Maintain up-to-date WI training modules														
Ensure operations personnel have completed WI training.														
Ensure well operating procedures reflect current operating practices.														
Initiate changes to procedures.	I	I	I	C	R	C	C		I	I	C			C
Ensure procedures are being followed by field personnel.														
Ensure all operating wells have a pressure gauge. Must be visible, appropriate range, have a stop pin.														

SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

Well Integrity Team



SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

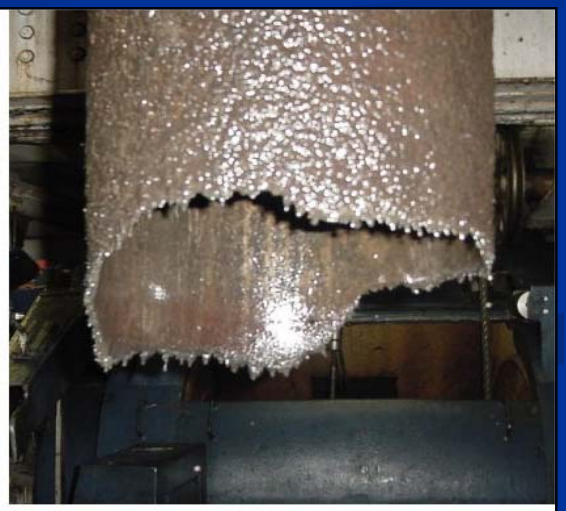
2) Well Operations

- ✓ Well Ownership & Handover
- ✓ Personnel Competency
- ✓ Procedures: startup, operating, shutdown
- ✓ Corrosion & Erosion Management

SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

3) Well Interventions

- ✓ Well Ownership & Handover
- ✓ Personnel Competency
- ✓ Procedures
- ✓ Records, document well service events



SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

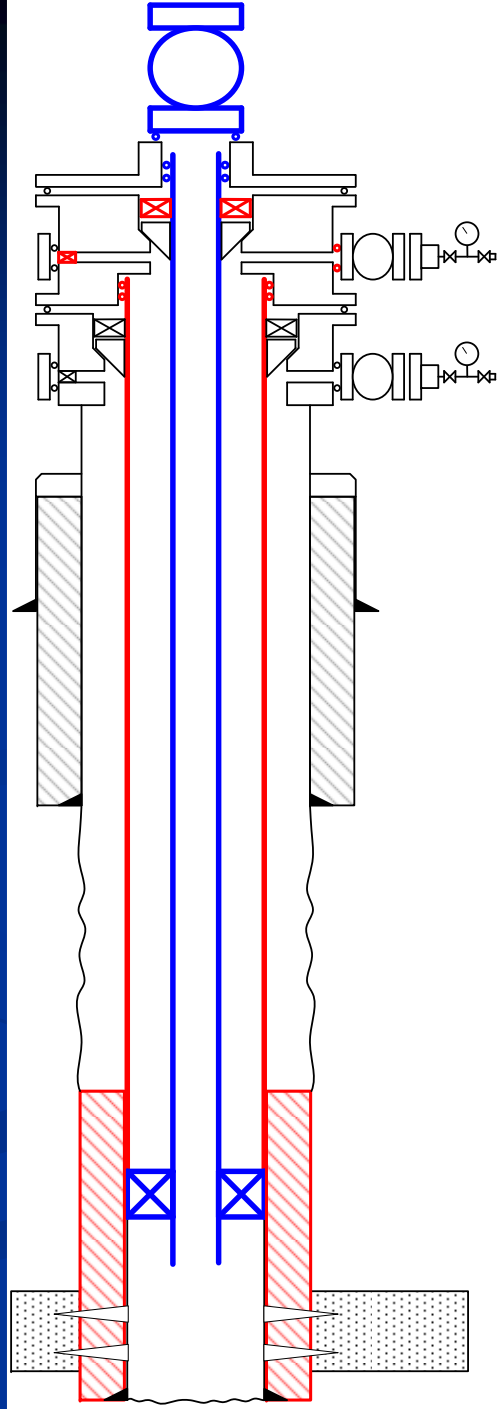
4) Tubing / Annulus Program

- ✓ Assigned operating pressure limits
- ✓ Report anomalies
- ✓ Respond to anomaly reports
- ✓ Every well is different – need to understand the risks of continued operation

SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

Barrier System

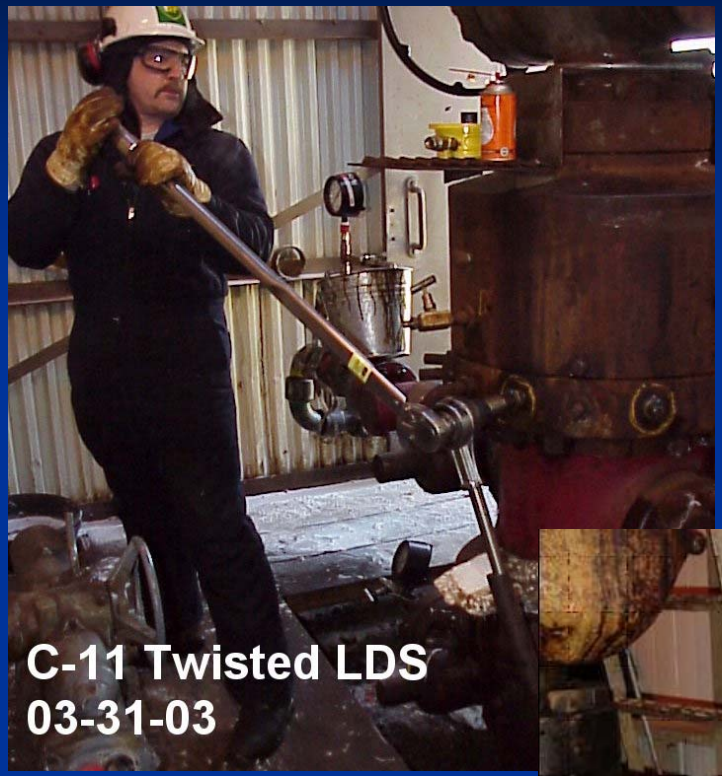
- NORSOK D-010 has very clear discussion of well barrier systems
- If whatever is holding pressure fails, where will the pressure go, and how will it react?
- Primary and Secondary barrier systems
- Acceptance Criteria – how much can it leak and be okay?
- Can you test the barrier system? How to identify if it has lost competency?



NORSOK D-010: "Well Integrity in Drilling and Well Operations"

5) Wellhead & Tree Maintenance

- ✓ Tree & wellhead valves serviced twice per year
- ✓ Wellhead Tech to handle wellhead leaks



SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

6) Safety Valve Program

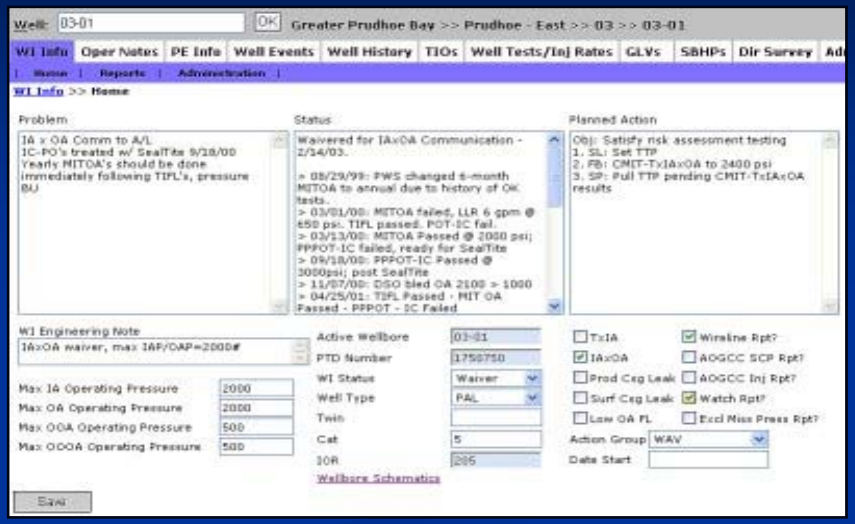
- ✓ Surface safety valves on all producers
- ✓ Downhole safety valves on gas injectors & offshore wells
- ✓ Tested 6 months

SPE 102524: "Well Integrity Operations at Prudhoe Bay, Alaska"

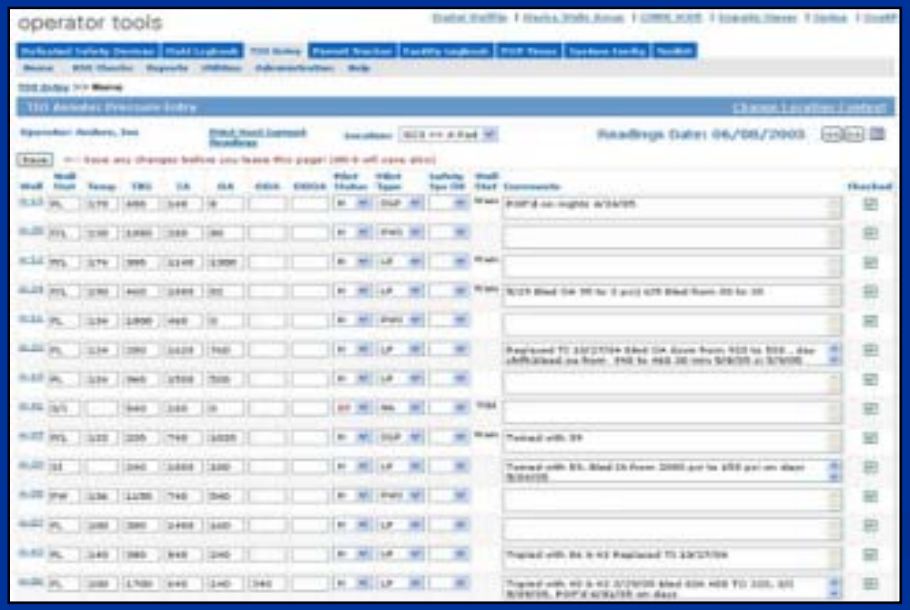
Data Management

- Data input
- Information retrieval
- Auto generated reports

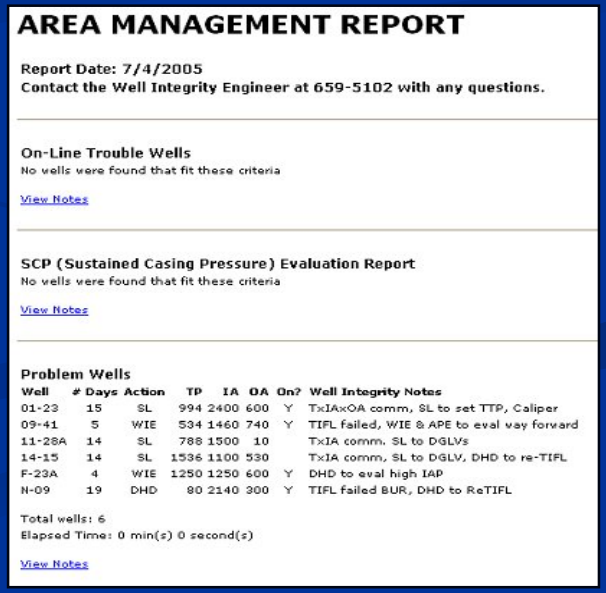
Retrieval



Input



Reports



AREA MANAGEMENT REPORT

Report Date: 7/4/2005
Contact the Well Integrity Engineer at 659-5102 with any questions.

On-Line Trouble Wells
No wells were found that fit these criteria

View Notes

SCP (Sustained Casing Pressure) Evaluation Report
No wells were found that fit these criteria

View Notes

Problem Wells

Well	# Days	Action	TP	IA	OA	On?	Well Integrity Notes
01-23	15	SL	994	2400	600	Y	TxIAxOA comm, SL to set TTP, Caliper
09-41	5	WIE	534	1460	740	Y	TIFL failed, WIE & APE to eval way forward
11-28A	14	SL	788	1500	10		TxIA comm. SL to DGLVs
14-15	14	SL	1536	1100	530		TxIA comm, SL to DGLV, DHD to re-TIFL
F-23A	4	WIE	1250	1250	600	Y	DHD to eval high IAP
N-09	19	DHD	80	2140	300	Y	TIFL failed BUR, DHD to ReTIFL

Total wells: 6
Elapsed Time: 0 min(s) 0 second(s)

View Notes

SPE 95813: "Enhancing Collaboration Between Engineering and Operations"

Well Integrity Diagnostics Report

- Annulus pressure > allowable pressure
- Annulus pressures not entered
- Overdue compliance work
- Injector with Tubing and A annulus pressure within 250 psi

Emailed automatically each morning

WELL INTEGRITY DIAGNOSTICS REPORT

Report Date: 9/16/2007

Wells Not Operable Showing to be On-Line

Well	WI Status	Type	Well Integrity Notes
GC-2C	Not Operable	PWI	LTSI, Well safed out per GC2 Ops Lead Tech

Total Wells: 1

Wells with High IA or OA Pressures:

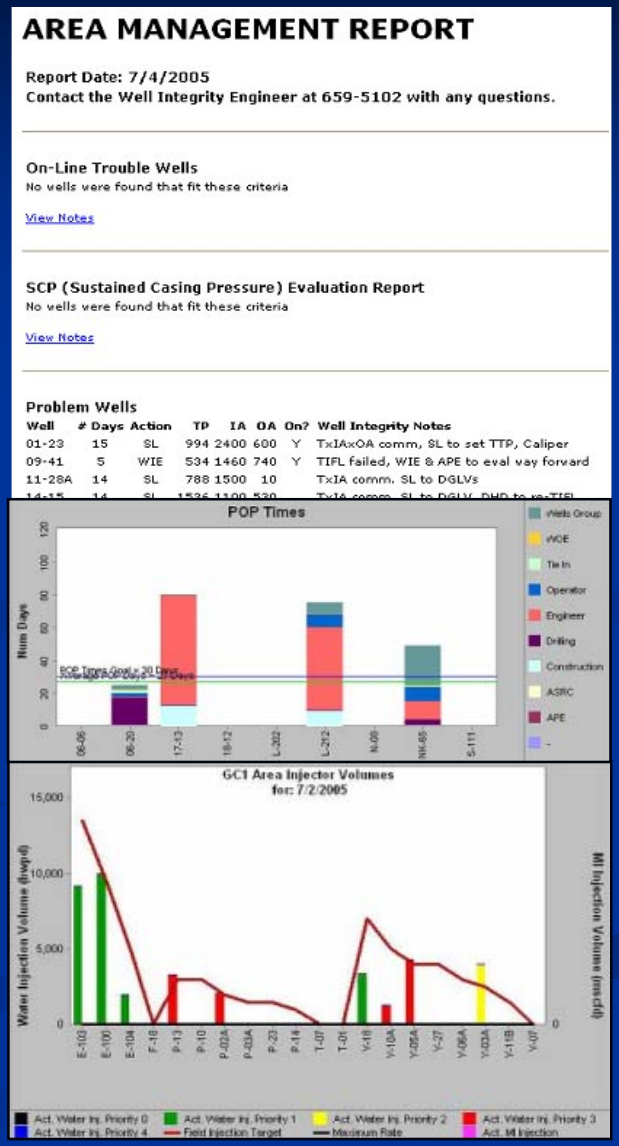
Well	WI Status	On?	Pressure Entry Date	FTP	IA	OA	Well Integrity Notes
E-14A	Under Eval		9/14/2007		**2150**	200	TxIA comm - F to MIT-IA
F-39	Operable		9/14/2007	150	**2060**	560	Careful bleeding OA - will produce sand up OA
F-43	Operable		9/14/2007	180	**2060**	80	High IAP is due to A/L. Well is SI - D to TIFL
N-26	Under Eval		9/14/2007	160	**2100**	0	TxIA comm, S to C/O S/O
P-08A	Operable		9/14/2007	0	**2160**	0	D to TIFL
S-103	Operable		9/14/2007	0	**2040**	400	RWO fixed TxIA comm - D to TIFL
S-12A	Under Eval		9/14/2007	0	**2100**	120	D to TIFL
S-21	Operable		9/14/2007	0	**2100**	0	D to TIFL
S-36	Operable		9/14/2007	0	**2100**	540	D to TIFL
S-37	Operable		9/14/2007	0	**2100**	130	D to TIFL
U-11B	Under Eval		9/14/2007		**2200**	200	High IAP due to A/L - S to change out S/O, set TTP
W-21A	Operable		9/14/2007	0	**2060**	0	D to TIFL

Auto Generated Reports

Area Management Report

"What gets measured, gets done"

- Regulatory
- Optimization



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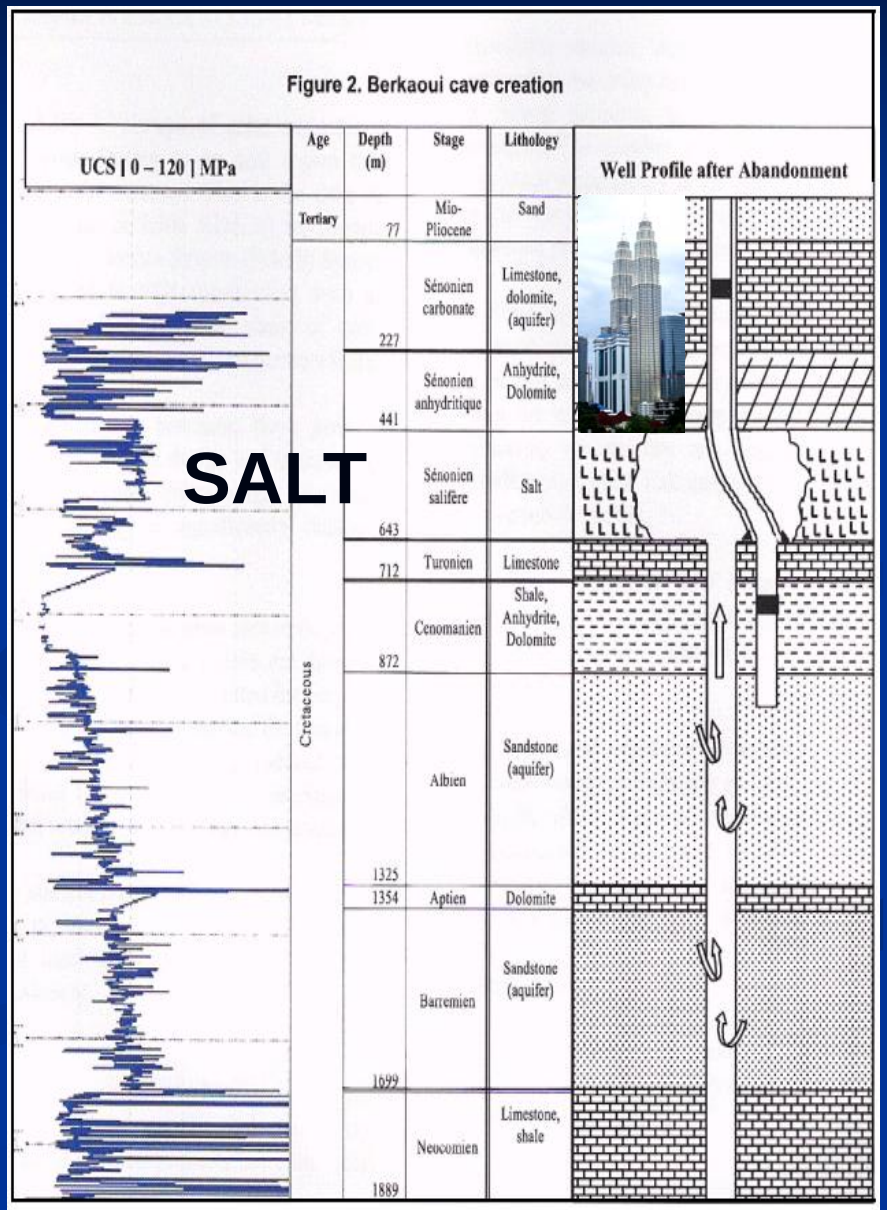
SPE 95813: "Enhancing Collaboration Between Engineering and Operations"

Underground Failures

- Algeria Cave Creation
- Indonesia Mud Volcano

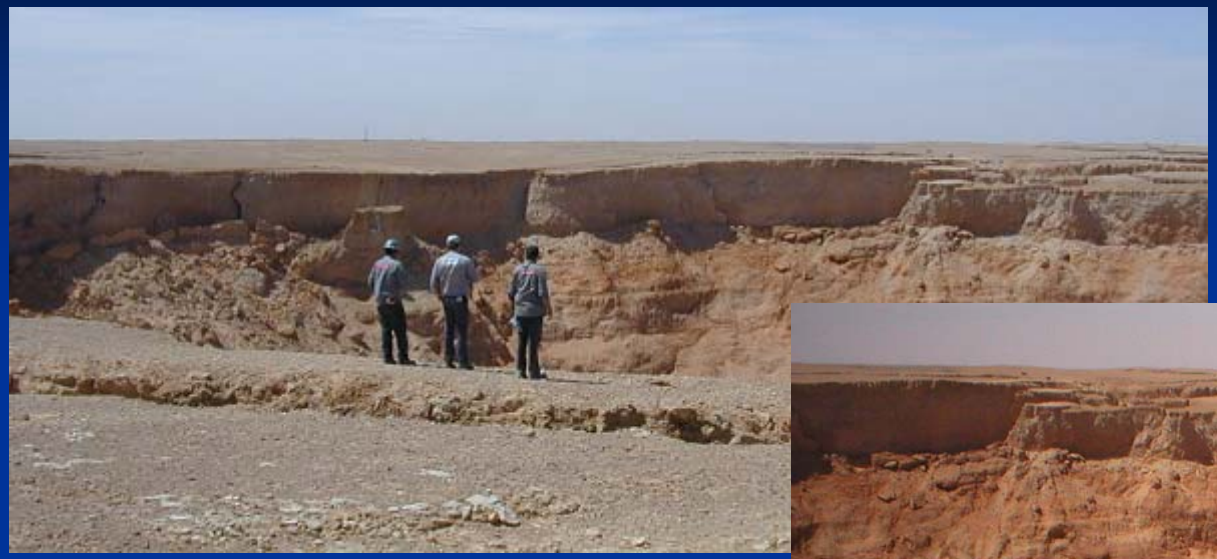
BerKaoui Cave Creation, Algeria

- Drilled in late seventies, original hole was lost leaving 700m uncased.
- A cavern formed in the salt formation.
- Collapsed in 1986, created a 200m by and 80m deep depression.



SPE 94427: "Northern Sahara Aquifers Protection"

The Result . . .



SPE 94427: "Northern Sahara Aquifers Protection”

Indonesia “Mud Volcano”

ANTARA NEWS 4 September, 2006

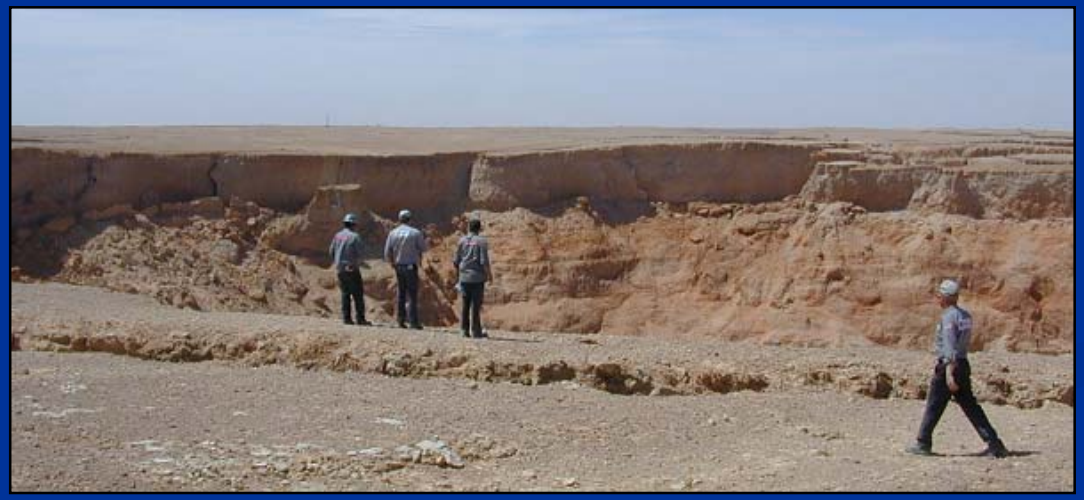
- 29 May 2006, flow of hot formation water (“mud”) began
- The East Java Police seized a rig belonging to oil and gas exploration company PT Lapindo Brantas. The seizure was made in order to bring the case to court
- The number of residents displaced by the mud has increased to an estimated 15,000 people after an emergency pond the firm erected to contain the mud collapsed.
- Mud flows cover an estimated 200 hectares (500 acres) of land in the Porong area
- The sinking of the land at 2km from the well is predicted to reach 60 centimeters within a year's time.

Indonesia Mud Volcano

Options?

Why is Well Integrity Important?

- Injury
- Environment
- Cost
- Liability
- Future generations



Well Integrity Checklist

- Assigned accountability & responsibility, team approach
- Audit Verification
- System covers design to abandonment
- Competent personnel
- Operating and well intervention procedures
- Annulus monitoring, engineering support
- Tree, wellhead and safety valve maintenance program

Reference Material: www.wellintegrity.net

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Wrap up

Shokran!

- References at www.wellintegrity.net
- Questions?