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**“APPLIED TECHNOLOGY AND
BEST PRACTICES IN CEE”**

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**MODERN TECHNOLOGICAL APPROACH
TO DRILLING AND COMPLETION OF
PRODUCTION WELLS AT THE
CROATIAN NORTH ADRIATIC OFF-
SHORE GAS FIELDS**

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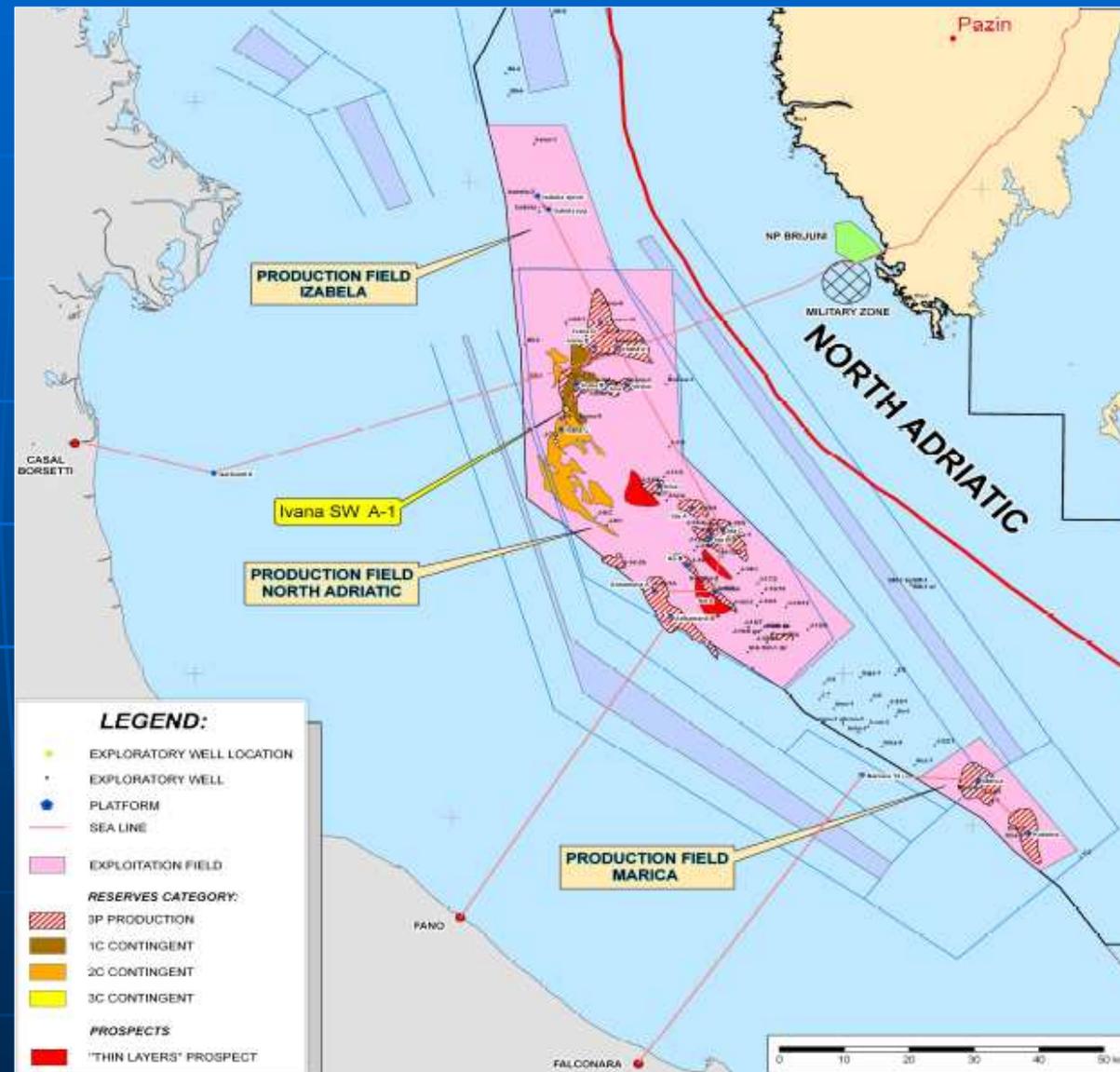
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CONTENT

- **Introduction**
- **Well Construction**
- **Well Completion**
- **Croatian Offshore Safety Regulations**
- **Conclusion**

NORTHERN ADRIATIC FIELDS SITUATION MAP

- INA's joint ventures
 - Inagip
 - Edina
- Start of development in 1999.
- Sea depth from 37 to 75 m
- 18 production platforms
- 46 production wells (40 slanted, 6 horizontal)
- 73 production strings
- Current production 5 M m³/day of gas
- 12 exploration wells (9 vertical, 3 slanted)



DEVELOPMENT PHASE JACK UP RIGS FLEET

- J/U Rig Labin - Croscos
 - Levingstone 111-C
 - Drawworks National 2000 HP
 - Year of built 1985
 - In operations up to 2003.
-
- J/U Rig Carl Norberg - Noble
 - Marathon LeTourneau 82-C
 - Drawworks National 2000 HP
 - Year of built 1976
 - In operations 2005 - 2007.
-
- J/U Rig Ocean King - Diamond
 - Marathon LeTourneau Class 116-C
 - Drawworks National 3000 HP
 - Year of built 1973
 - In operations 2008 - 2010.



WELL CONSTRUCTION TECHNOLOGY APPROACH

CONDUCTOR PIPE 26"/ 20"

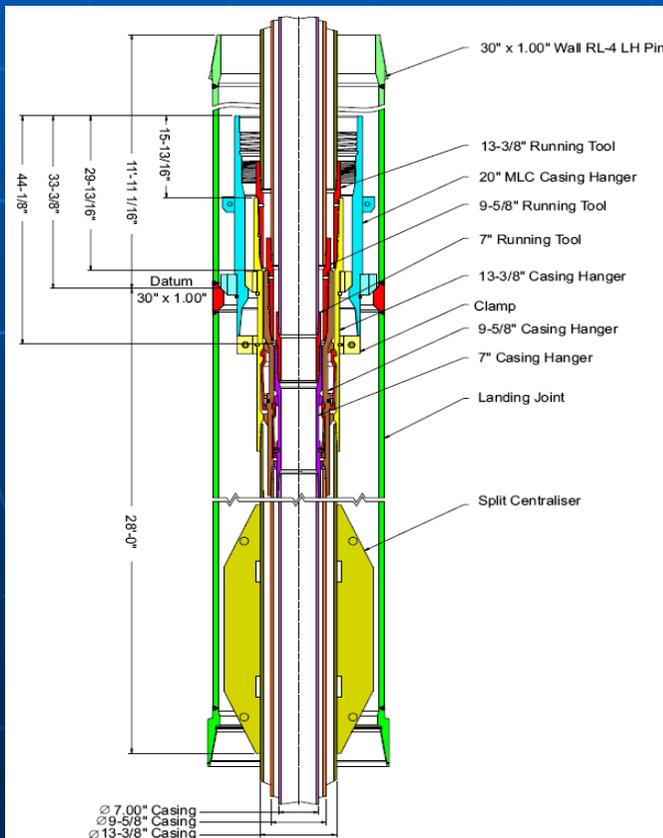
- Driven before rig arrival after jacket installation
- Penetration in sea bottom 50 m
- Washed by JU rig with 22"/16" bit



WELL CONSTRUCTION TECHNOLOGY APPROACH

MUDLINE SUSPENSION

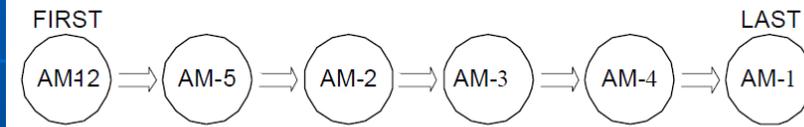
- System for temporary abandonment of explorative well (2-3 m above mud line)
- Tie-back and completion ones when production platform is installed



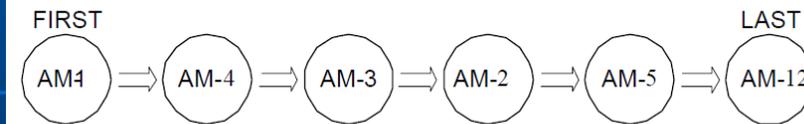
BATCH MODE DRILLING

- Phase by phase drilling operations
- Time saving due to operations repetition
- Longitudinal and/or transversal skid of cantilever

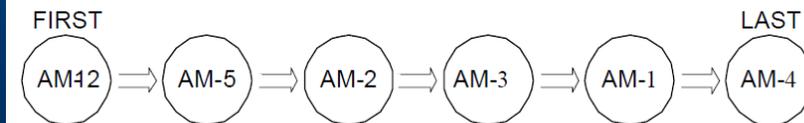
a) WASHING PHASE CONDUCTOR PIPE 26"



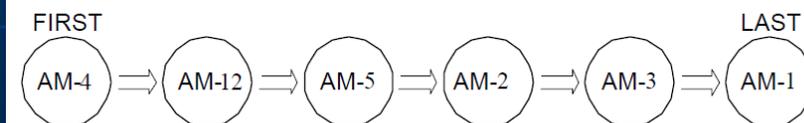
b) DRILLING PHASE 16"



c) DRILLING PHASE 12 1/4"



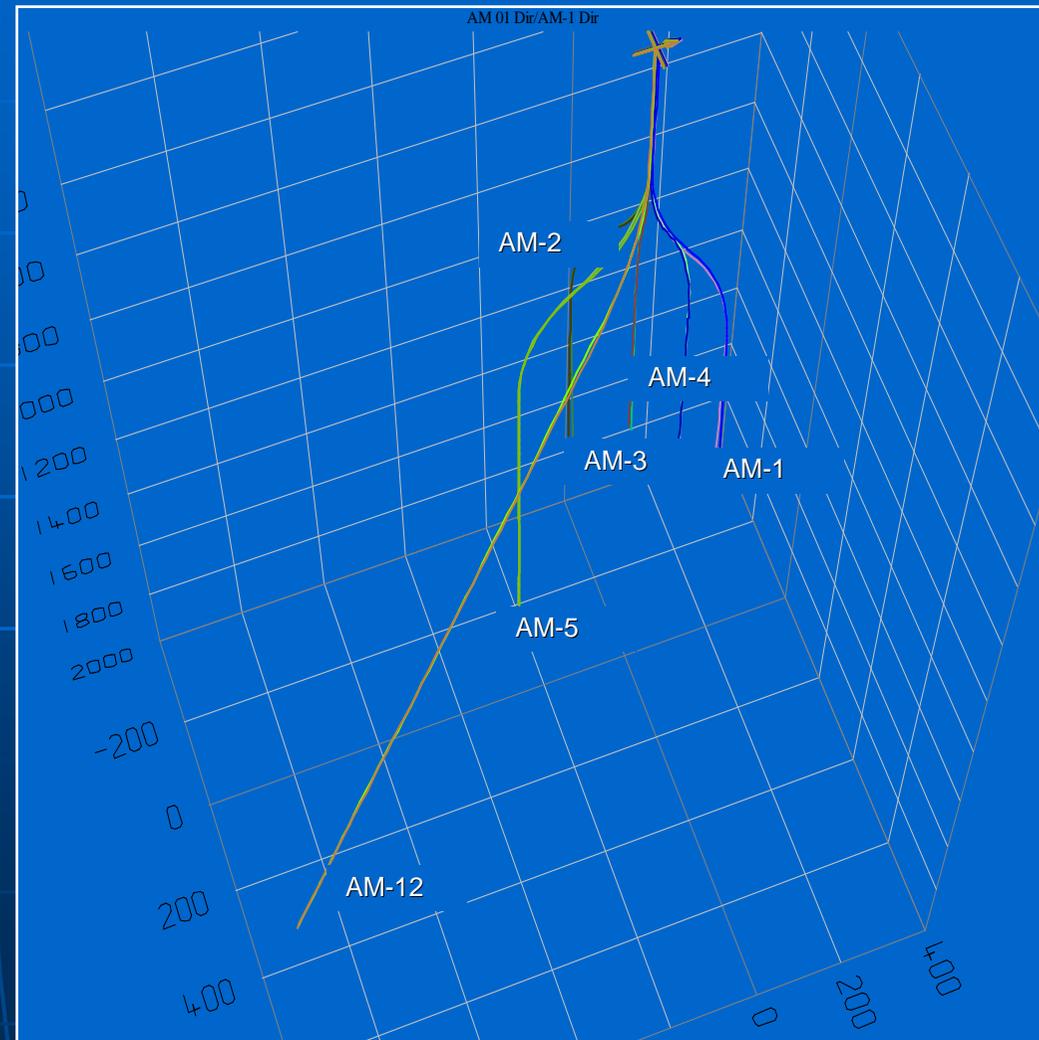
d) DRILLING PHASE 8 1/2"



WELL CONSTRUCTION TECHNOLOGY APPROACH

WELL PLANNING

- Developing thick/thin sand layers and carbonates
- One to six wells per jacket
- Targeting up to 31 layers from the one jacket (Annamaria)
- Wells shape "S" or "J"
- KOP below 13 3/8" or 9 5/8" casing shoe
- Build up by PDM
- Hold/drop in 8 1/2" section by steerable motor (PD)
- WL logging and/or LWD
- Water Base mud
- Inner string (surface csg) and Perkins method cementing



WELL CONSTRUCTION TECHNOLOGY APPROACH

SURFACE CASING PHASE

- Isolating the unconsolidated shallow formations, potential gas lenses and water layers
- Lithology: sand, shale, lignite
- Preparing kill mud MW=1,4 kg/l
- Drilling 16" phase with tricone bit
- Running FW-GE simple, easy to run mud MW=1,1 kg/l
- Setting 13 3/8" casing shoe at approx. 300 m
- Cementing by DP 5" inner string method stinged into casing shoe or collar (cem. slurry = 1,98 kg/l)
- TOC at cellar deck (remedial cement job)
- M/U Wellhead and test at 40 bar

	Cum. Len. (m)
5" 19.50 DPG, 10% Wear	
15 x 5" HWDP (15 joints)	222.99
Crossover	82.98
1 x 8" DC	81.95
Hydraulics Jar	72.97
2 x 8" DC (2 joints)	63.12
8 1/32" NMDC	44.29
UBHO Sub	35.26
8" NMDC	34.23
PowerPulse	25.23
8-1/16" NM Pony DC	16.65
8-1/16" NM Pony DC	13.59
NM Float Sub	10.53
A962M5640XP (1.8 deg)	9.72
16" Bit	0.46

WELL CONSTRUCTION TECHNOLOGY APPROACH

INTERMEDIATE CASING PHASE

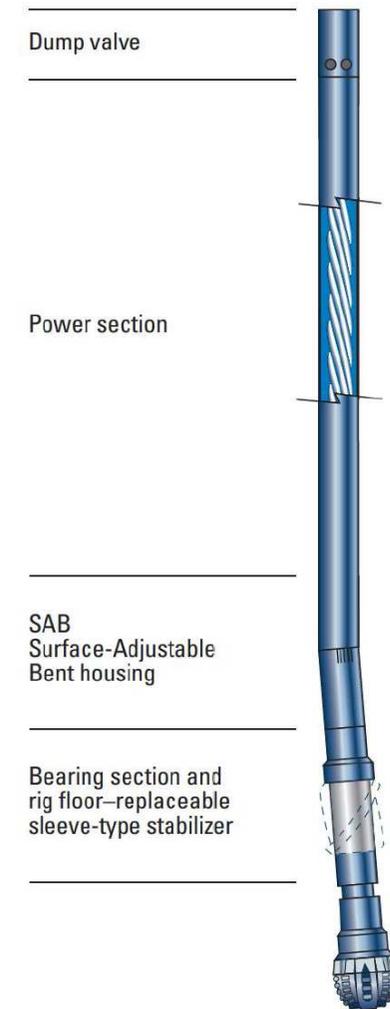
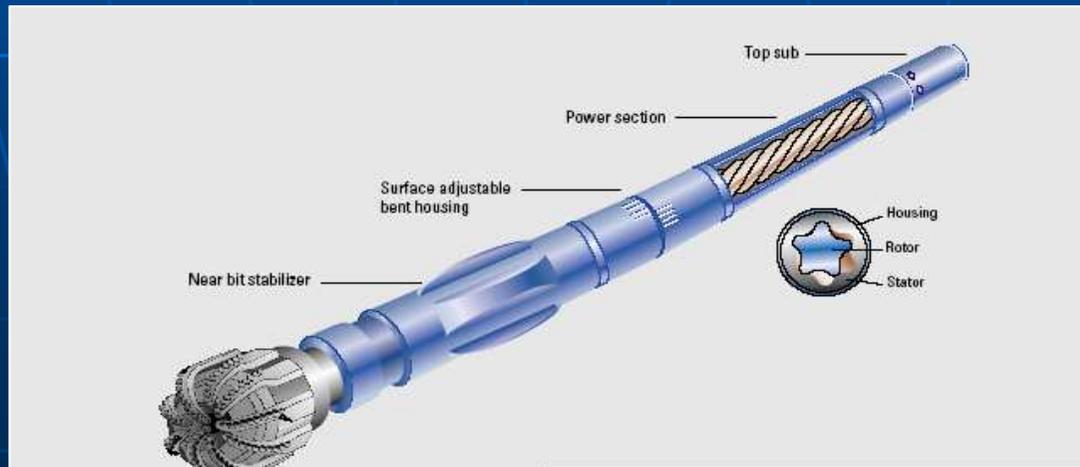
- Setting above well targets and below build-up section
- Lithology mostly shale with thin sand layers
- Drilling 12 1/4" phase with tricone or PDC bit
- Running FW-LS low lime content, environmental friendly mud MW=1,15 kg/l
- Build up upto 6 deg./100 m using PDM
- Setting 9 5/8" casing shoe at 600 - 900 m TVD
- Cementing by Perkins method with non rotating drillable plugs using two cem. slurries (1,5 kg/l and 1,8 kg/l)
- TOC at 100 - 150 m above 13 3/8" shoe
- M/U Casing spool and test at 100-120 bar

	Cum. Len. (m)
5" 19.50 DPG, 10% Wear	
12 x 5" HWDP (11 joints)	215.32
Hydraulic Jar	103.50
5 x 5" HWDP (5 joints)	93.88
Crossover	47.07
Circ. Sub	46.04
8 1/32" NMDC	45.12
8" NMDC	36.09
PowerPulse	27.09
8-1/16" NM Pony DC	18.51
8-1/16" NM Pony DC	15.45
NM Float Sub	12.39
11 3/4 NM Stabilizer	11.58
A800M4553XP (1.5 deg)	9.17
12 1/4" Bit	0.25

WELL CONSTRUCTION TECHNOLOGY APPROACH

POWER PAK MOTOR

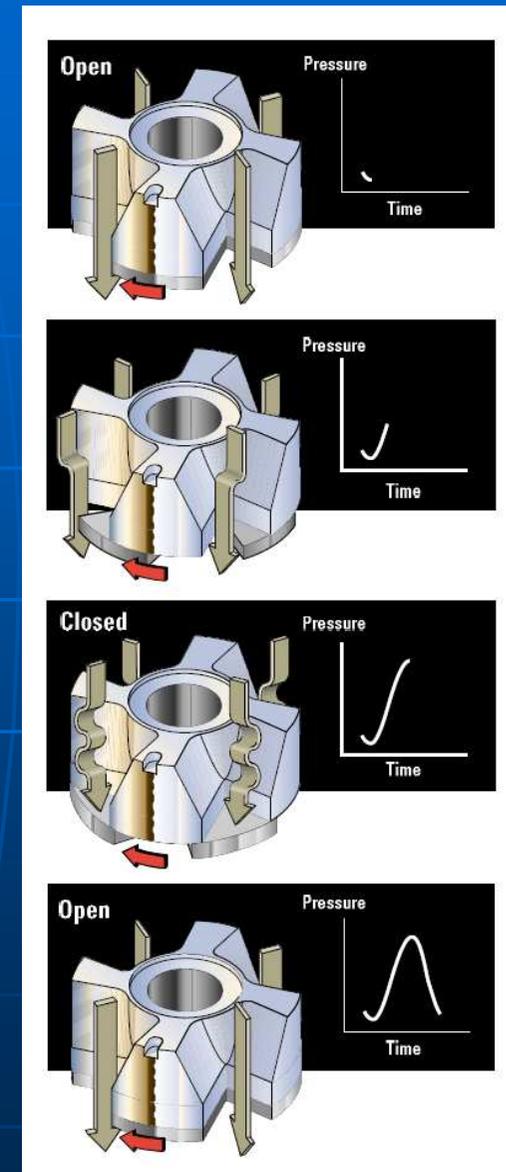
- **Mud-lubricated bearings (M series)**
- **Variety of rotor/stator configurations (power, torque, speed, flow)**
- **Minimum interference with MWD**
- **Increasing ROP**
- **Reduce casing and bit wear**



WELL CONSTRUCTION TECHNOLOGY APPROACH

MWD POWER PULSE

- Mud pulse telemetry tool that establishes the benchmark for reliability and data transmission rates
- Robust and reliable transmission in all mud types
- Continuous D&I measurements save rig time and minimize doglegs
- Data transmission rates of up to 16 bps provide high resolution, real-time logs
- Optional gamma ray sensor



WELL CONSTRUCTION TECHNOLOGY APPROACH

PRODUCTION CASING PHASE

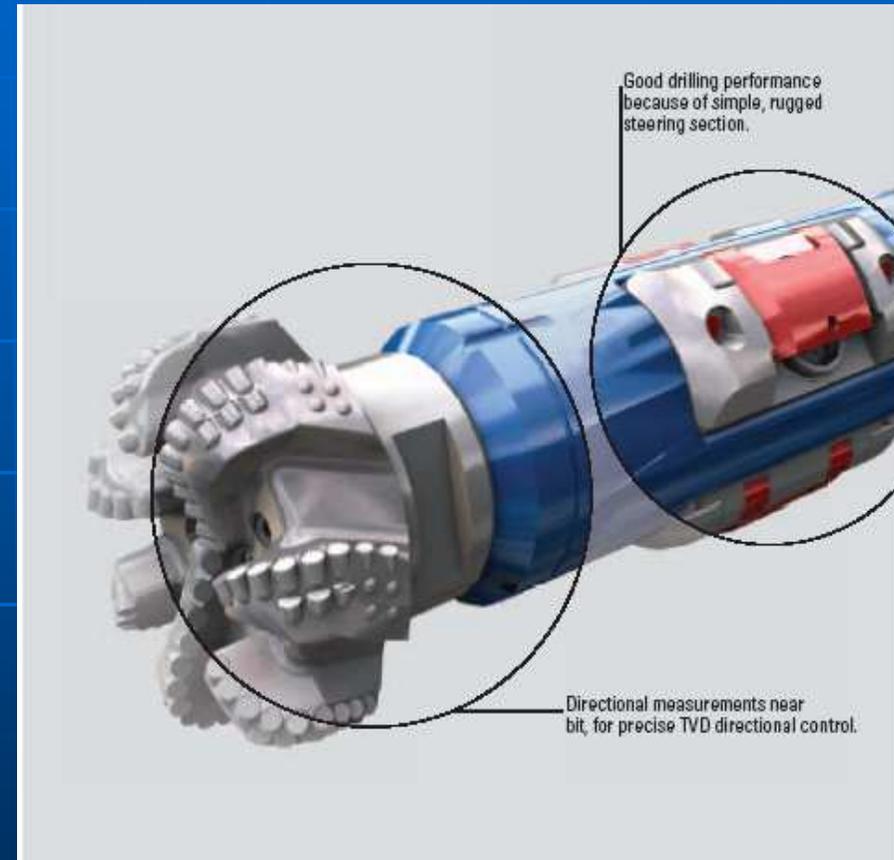
- Covering all predicted production intervals
- Lithology alternation of shale and sand layers
- Drilling 8 1/2" phase with PDC bit
- Running FW-PO-LU environmental friendly mud MW=1,25 kg/l
- Hold an angle (45-60 deg. "J" shape) or drop to vertical ("S" shape wells) using steerable motor
- Setting 7" casing shoe at TD 1400 – 2400 m MD
- Cementing by Perkins method with non rotating drillable plugs using one or two cem. slurries (1,5 kg/l and 1,7 kg/l)
- TOC at 200 m above 9 5/8" shoe
- M/U Tubing spool and test at 140-160 bar

	Cum. Len. (m)
5" 19.50 DPS	218.49
5" HWDP (9 joints)	208.49
Hydraulic Jar	124.56
5" HWDP (9 joints)	115.28
Circulating sub	31.35
6 3/4" NMDC	30.43
TeleScope	21.06
GVR	12.58
PD NM Flex Collar	9.04
PD SRX	6.16
PD 675 X5	4.41

WELL CONSTRUCTION TECHNOLOGY APPROACH

POWER DRIVE

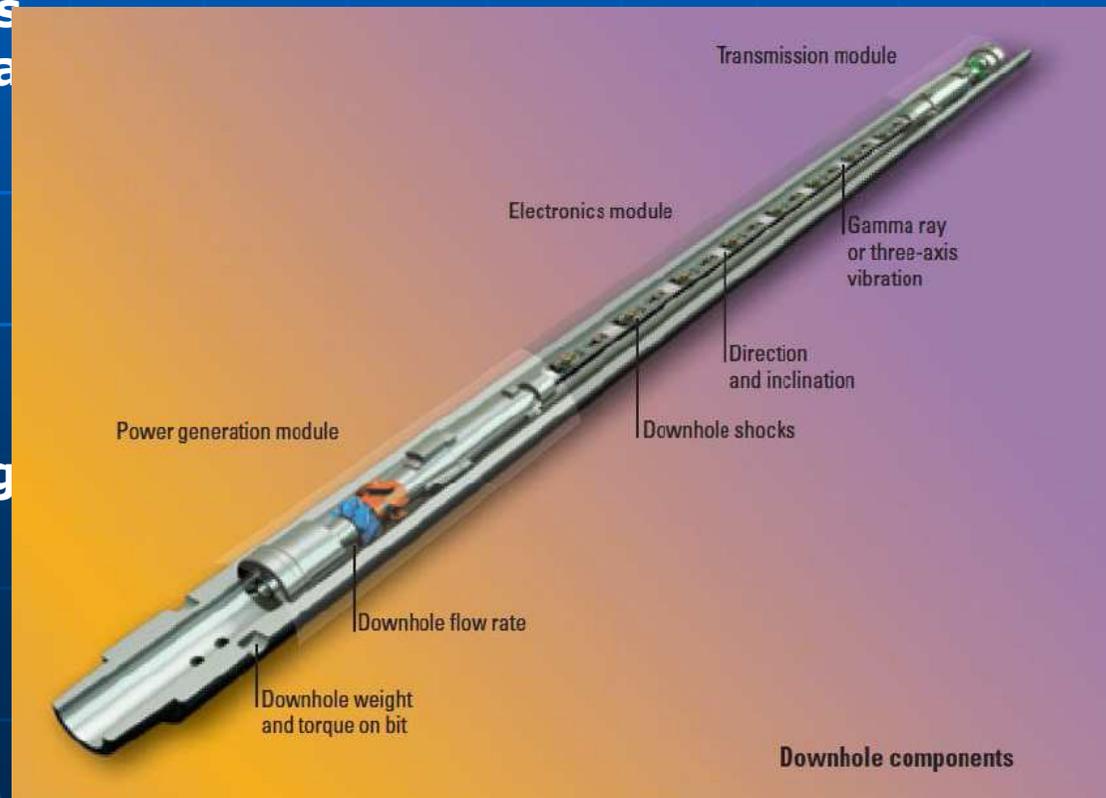
- **Push-the-bit system designed for full directional control while rotating the drillstring**
- **Accurate drilling and wellbore placement**
- **Near-bit measurements in real time**
- **Efficient downlink systems and automatic inclination hold**
- **Optional azimuthal gamma ray sensor**



WELL CONSTRUCTION TECHNOLOGY APPROACH

MWD TELESCOPE

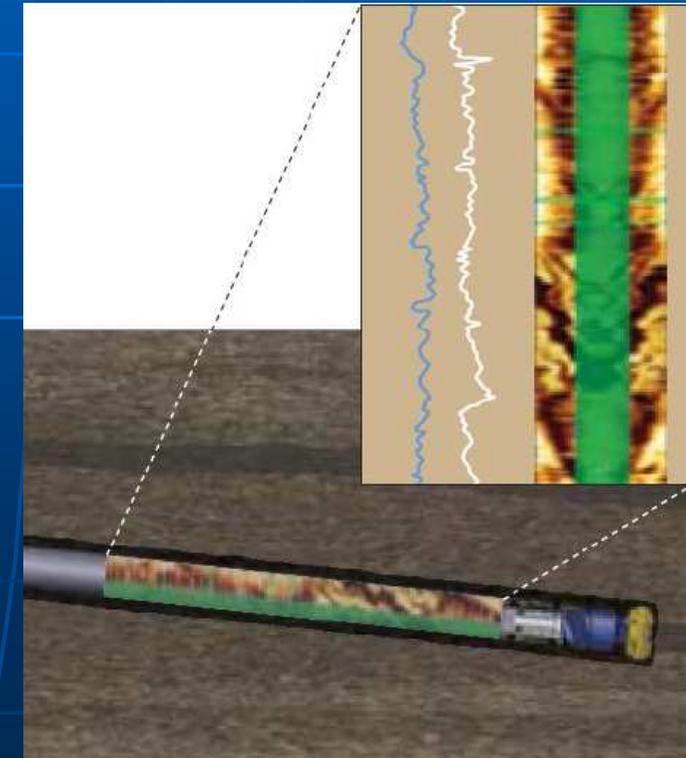
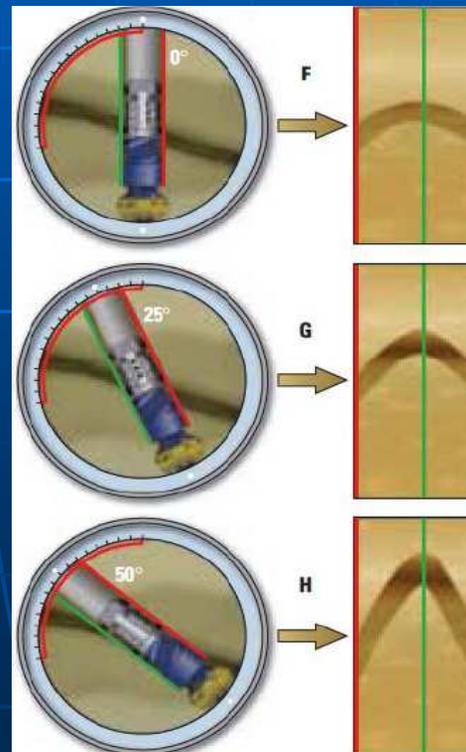
- Hi-speed telemetry while drilling system
- Ability to power and transmit data from multiple downhole tools
- Accurate continuous dynamic and static directional and inclination measurements
- Real time updates on shock, flow and vibrations
- Data memory enables post drilling analysis



WELL CONSTRUCTION TECHNOLOGY APPROACH

LWD GVR

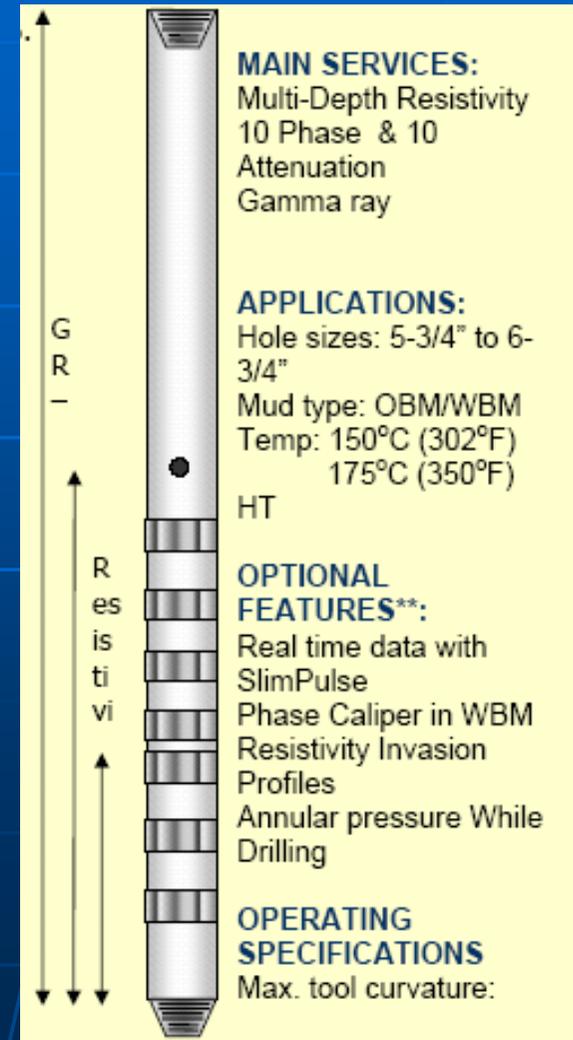
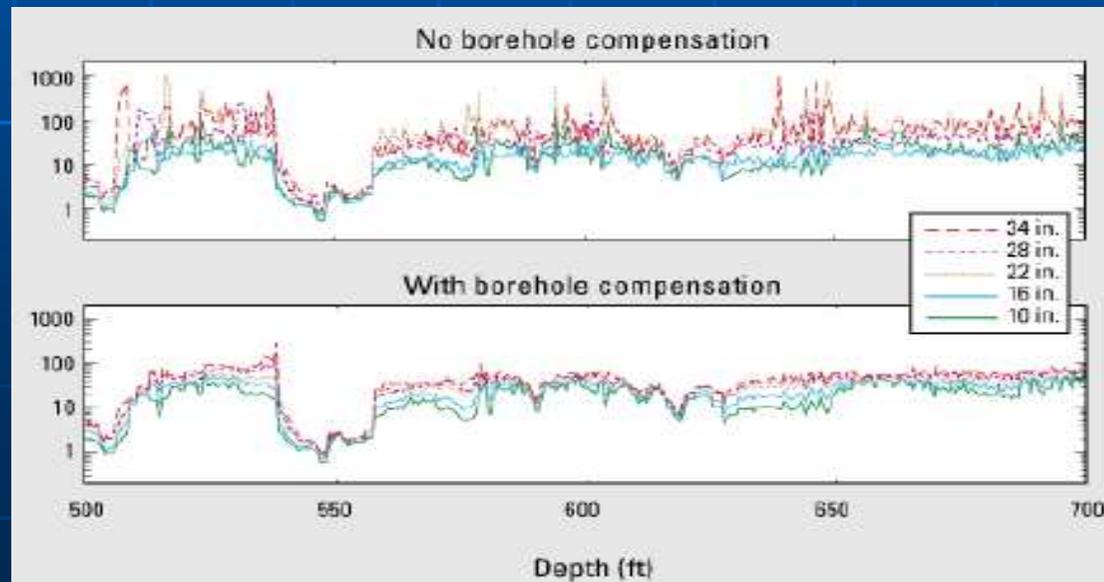
- **GeoVision Resistivity tool**
- **While-drilling visualization and dip interpretation of real-time resistivity images**
- **Interactive 3D visualization of borehole images along the well trajectory**
- **Possibility for resistivity at the bit monitoring in case of running w/o motor**



WELL CONSTRUCTION TECHNOLOGY APPROACH

LWD ARC VISION

- Array resistivity compensated tool
- Resistivity, gamma ray, inclination and annular pressure data
- Can withstand a high sand content and high mud flow rates which ensure maximum power transfer

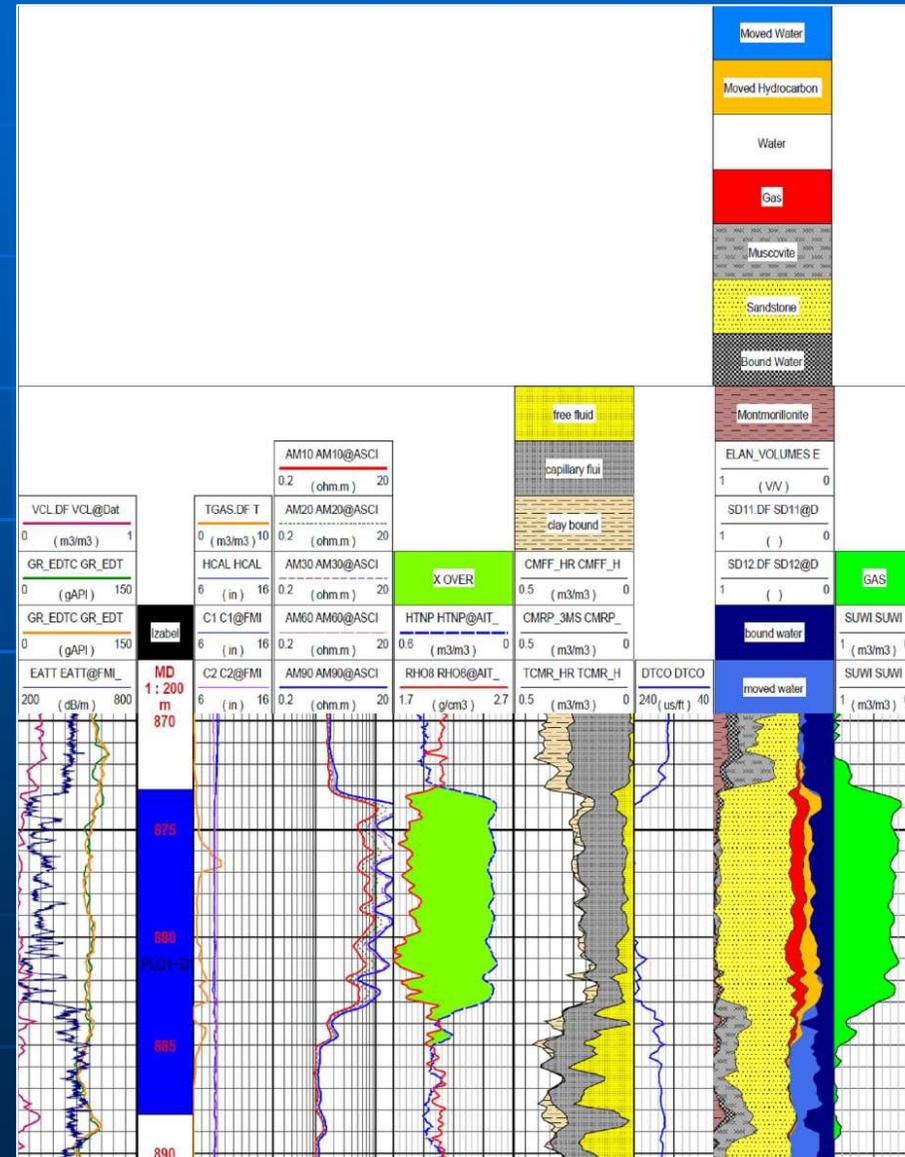


WELL CONSTRUCTION TECHNOLOGY APPROACH

WL LOGGING

Quick look combined log

- Caliper
- Gamma ray – nature radioactivity
- Resistivity
- MDT – modular dynamic tester
- Neutron – neutron porosity
- Density
- CMR – combined magnetic resonance



WELL COMPLETION - GENERAL

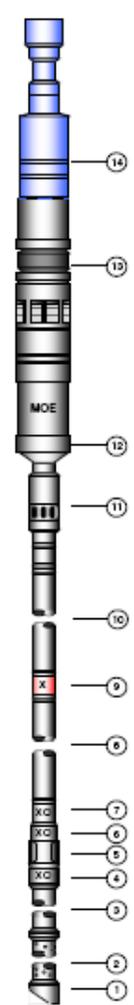
- Dual & single completion – 2 3/8”; 4,7#; L-80, P-110; ADMS, VamTOP (Izabela); IKA A-1 DIR – 2 7/8”; 6,7#; L-80; ADMS
- Material used:
 - P-110 & L-80 (Ika & Izabela) for tubulars;
 - L-80, AISI 41XX, AISI 316, 9CR-1MO for DHE;
 - Nitrile, Viton & Teflon for sealing Items
- Wellhead & X-mass – API material class D.D.
- Completion fluid – brine CaCl_2 ; SG= 1,20

WELLS COMPLETION – PHASES GENERAL

- **Open hole completion & isolation**
- **Well preparation for completion**
- **Sand layers overbalanced perforating (phase 2)**
- **Perforations back surging**
or
- **TCP & back surging (phase 3)**
- **Frack & pack or high rate water pack gravel packing**
- **Well completion**
- **Well cleaning & testing**

OPEN HOLE COMPLETION & ISOLATION – IKA CARBONATES

- GP packer, MOE, SSD (close up), “X” LN, shear out ball seat sub, perforated tubing, mule shoe guide
- Spotted 0,5 m Baracarb
- Shifting tool closes SSD when pooh setting tool
- Outside liner 5” cca 20 m in IKA A-2,3 HOR wells
- Inside casing 7” 0,5 m in IKA B-1 DIR well



Perf	Dev °	TOP	BOTTOM	NET	
					Casing: Liner
Sand Size:		Fluid:			
Item	Description				
	Setting Tool + X-Over+Pup joint				
14	G.P. Packer size 70B4-40 mod SC1R				Top Center
13	Millout Extension 5 1/2" LTC Pin x Pin				
12	X-Over 5 1/2" LTC Box x 2 3/8" 4.7 #/ft ADMS Box				
11	SSD 'CMD' 1.875" - 2 3/8" 4.7 #/ft ADMS				
10	Tubing 2 3/8" 4.7 #/ft ADMS				
9	Landing Nipple 'X' 1.875" - 2 3/8" 4.7#/ft ADMS				
8	Tubing 2 3/8" 4.7 #/ft ADMS				
7	X-Over 2 3/8" 4.7 #/ft : ADMS Box x PJD Pin				
6	X-Over 2 3/8" 4.7 #/ft PJD Box x 2 7/8" 6.5 #/ft NU Pin				
5	Shear Out Ball Seat 2 7/8" NU Box x 3 1/2" EU Pin				
4	X-Over 3 1/2" EU Box x 3 1/2" 9.2 #/ft PJD Pin				
3	Tubing 3 1/2" 9.2 #/ft PJD				
2	Perforated Tubing 3 1/2" 9.2 #/ft PJD				
1	Pup Joint 3 1/2" PJD Box x 1/2 M.S.				
BHA Length					499.70 m

WELL PREPARATION

- Clean fluid (20 NTU minimal) and working environment are mandatory for GP installation
- Typical well cleaning programme:
 - RIH taper mill & scraper
 - Mud conditioning and circulating
 - Push pill → caustic pill → acid pill → neutralization pill → sea water
 - Sea water displacement w/ 1,20 kg/l filtered CaCl_2 brine
- Cartridge & de filtering units used

PERFORATING

- **Wire line conveyed casing gun in case of Frac & Pack**
- **4 1/2"; 12 spf; 135/45°; DX; big hole charges**
- **Under overbalanced conditions of 1,20 kg/l filtered CaCl₂ brine**
- **Usually not noticed significant brine losses after perforating**

PERFORATING & BACK SURGING

- TCP-DST in case of HRWP
- 4 1/2"; 12 SPF; 135/45°; RDX; Big Hole charges
- “Clean perforations” mandatory for effective HRWP gravel packing
- Cca 300 – 500 psi underbalance applied
- Pressure recorded downhole used for pressure build up analysis
- If some sand were recorded on the surface downhole valve were closed ASAP
- LCM pill spotted

GRAVEL PACKING

- **Technique applied:**
 - **Alpha / Beta for horizontal open hole**
 - **Frack & Pack**
 - **High rate water pack**
- **Cased hole GP technique selection criteria:**
 - **Frack & Pack were preferred technique due to near wellbore skin bypass, vertical sublayers connectivity and turbulence effect reduction**
 - **Limitation factors were vicinity of free water and no existence of good barriers above and below the layer**
 - **For all other situations HRWP in combination w/ back surging were preferred technique**

GRAVEL PACKING - FRAC & PACK

- “Econoprop” man made 30-50 US mesh propanant used
- Non damaging 2,2 - 2,5% VES (Visco Elastic Surfactant) in sea water w/3% KCl as a carrier fluid
- “Slim pack” prepacked screens 4” gauge 8

GRAVEL PACKING - HRWP

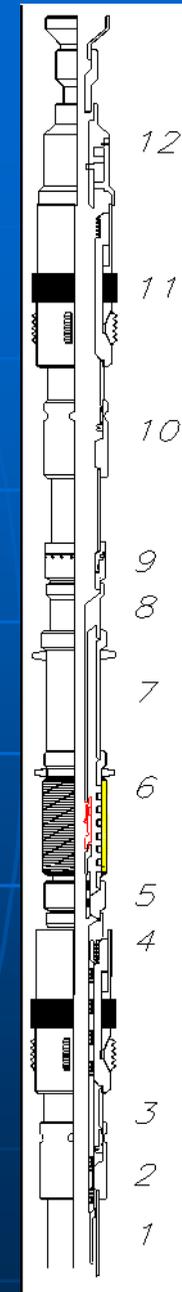
- Standard sand 40-60 US mesh used
- CaCl_2 1,20 kg/l brine as a carrier fluid
- “Slim pack” prepacked screens 4” gauge 8
- Acid job w/ HCOOH 10% performed in case of LCM pill spotted after “back surging”

GRAVEL PACKING – HORIZONTAL OPEN HOLE

- Standard sand 20-40, premium screen fine mesh
- CaCl_2 1,30 kg/l brine as a carrier fluid

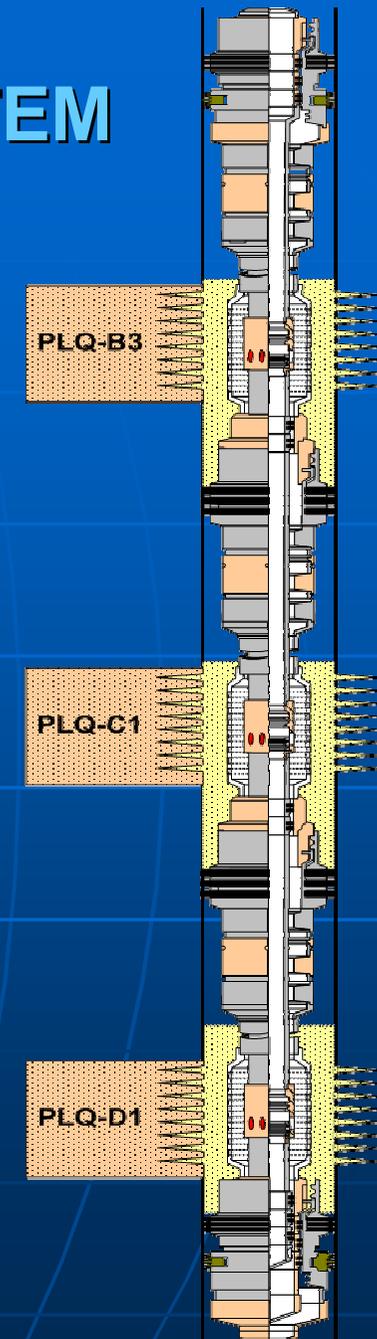
DOUBLE PIN SUB

- Mechanical system for fluid loss control after gravel packing
- Using double pin sub inner string w/SSD (close up) is deployed w/GP assembly together
- Circulation during GP job is allowed through opened SSD
- Layer-SSD is closed w/ shifting tool when the crossover tool is pulled after the job
- Can be used for layer by layer application



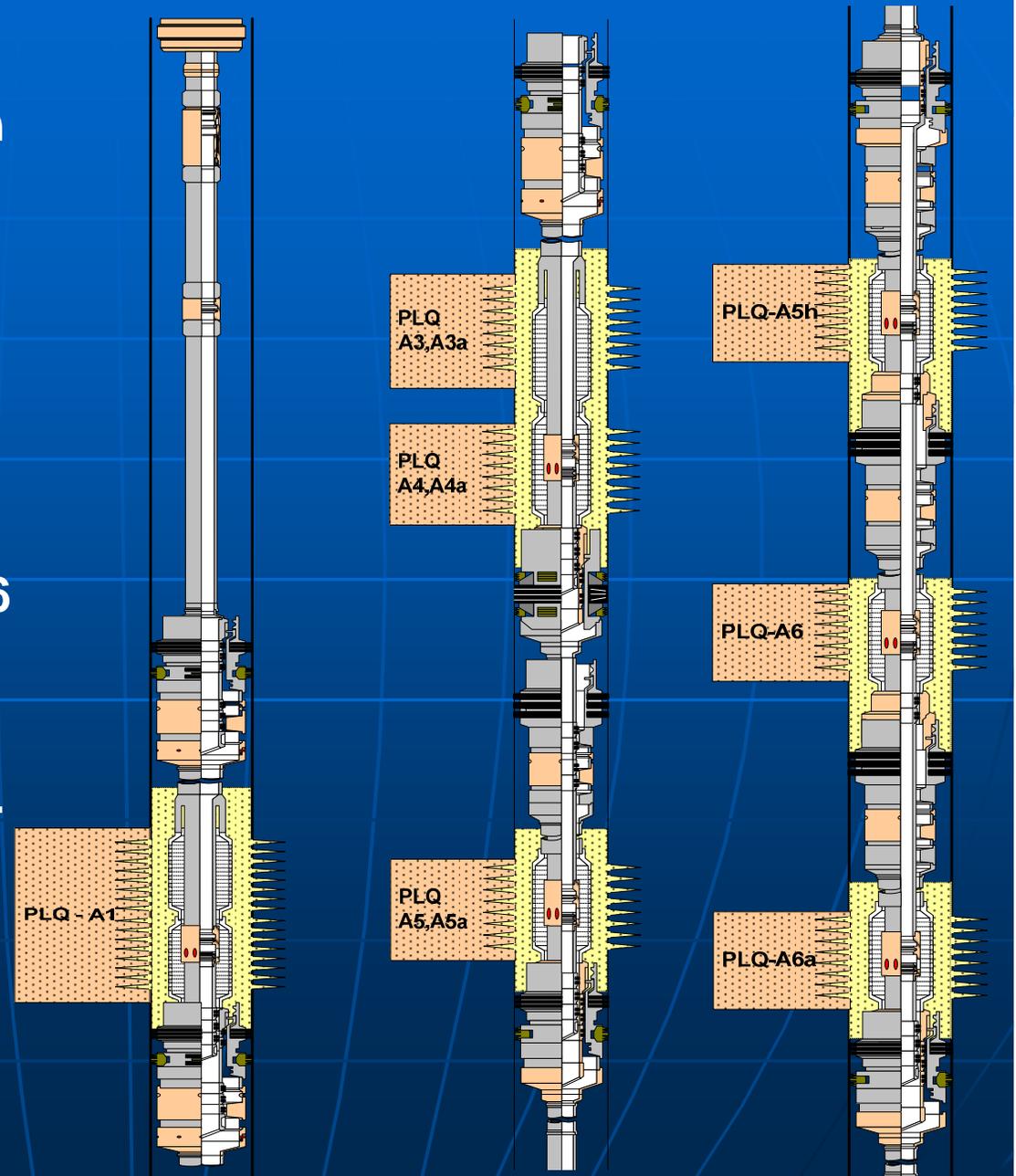
SINGLE TRIP MULTI ZONAL SYSTEM

- Allows multiple zone to be gravel packed in the single trip
- Consisting of multiple sets of screens and packer assemblies which are runs in to the well in one trip
- During gravel packing each zone is completely isolated from other
- Operates using the same positions incorporated in standard GP assembly; squeeze, circulating and reverse
- Substantially reduces rig time and costs associated w/ standard multiple zone system

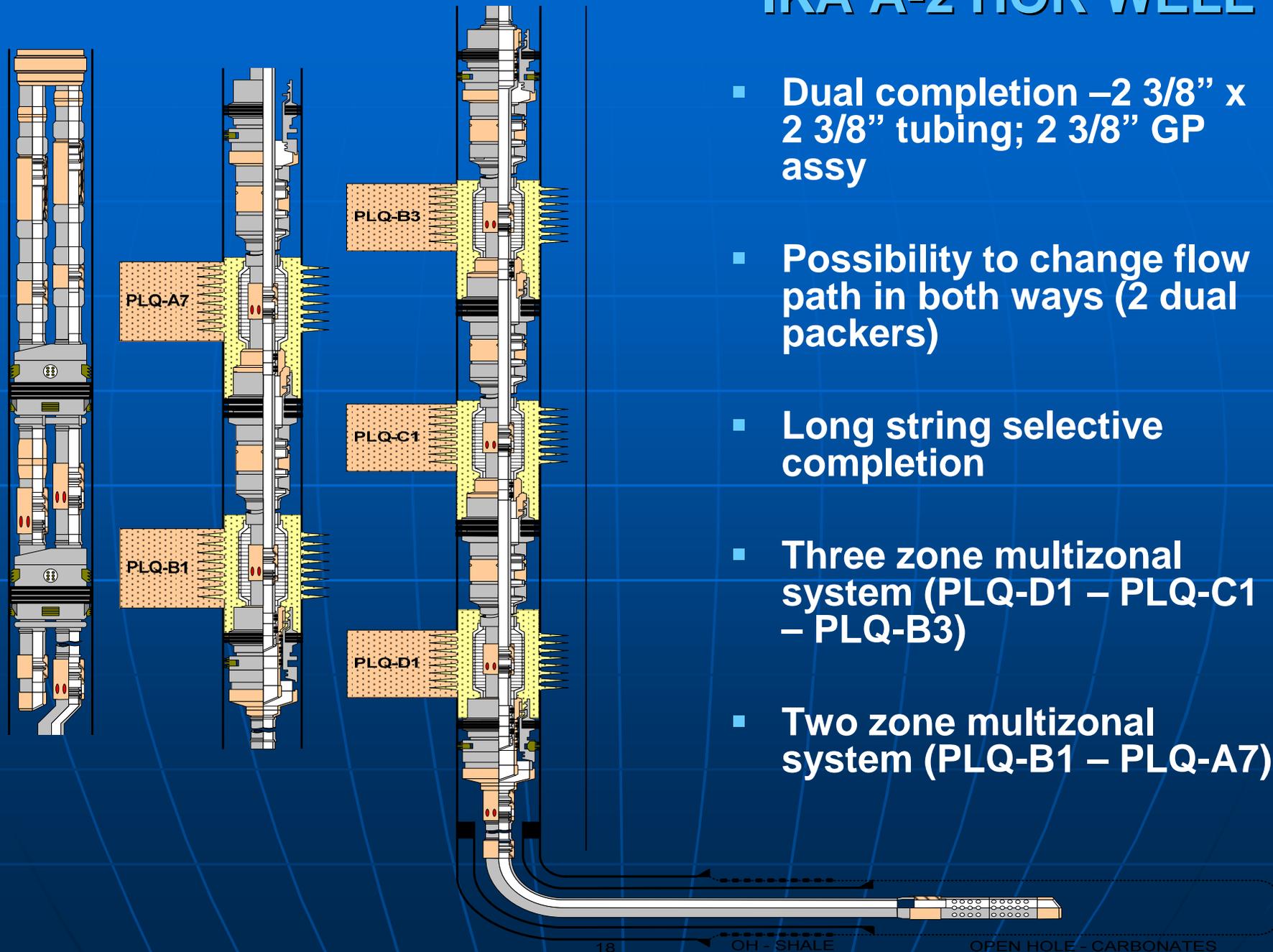


IKA A-1 DIR WELL

- Single selective completion
– 2 7/8” tubing; 2 3/8” GP
assy
- Two zone multizonal
system (PLQ-A8 – PLQ-
A12)
- Three zone multizonal
system (PLQ-A6A – PLQ-A6
– PLQ-A5H)
- Double pin sub used on
layers PLQ-A4, A4A & PLQ-
A3, A3A and layer PLQ-A1
completion

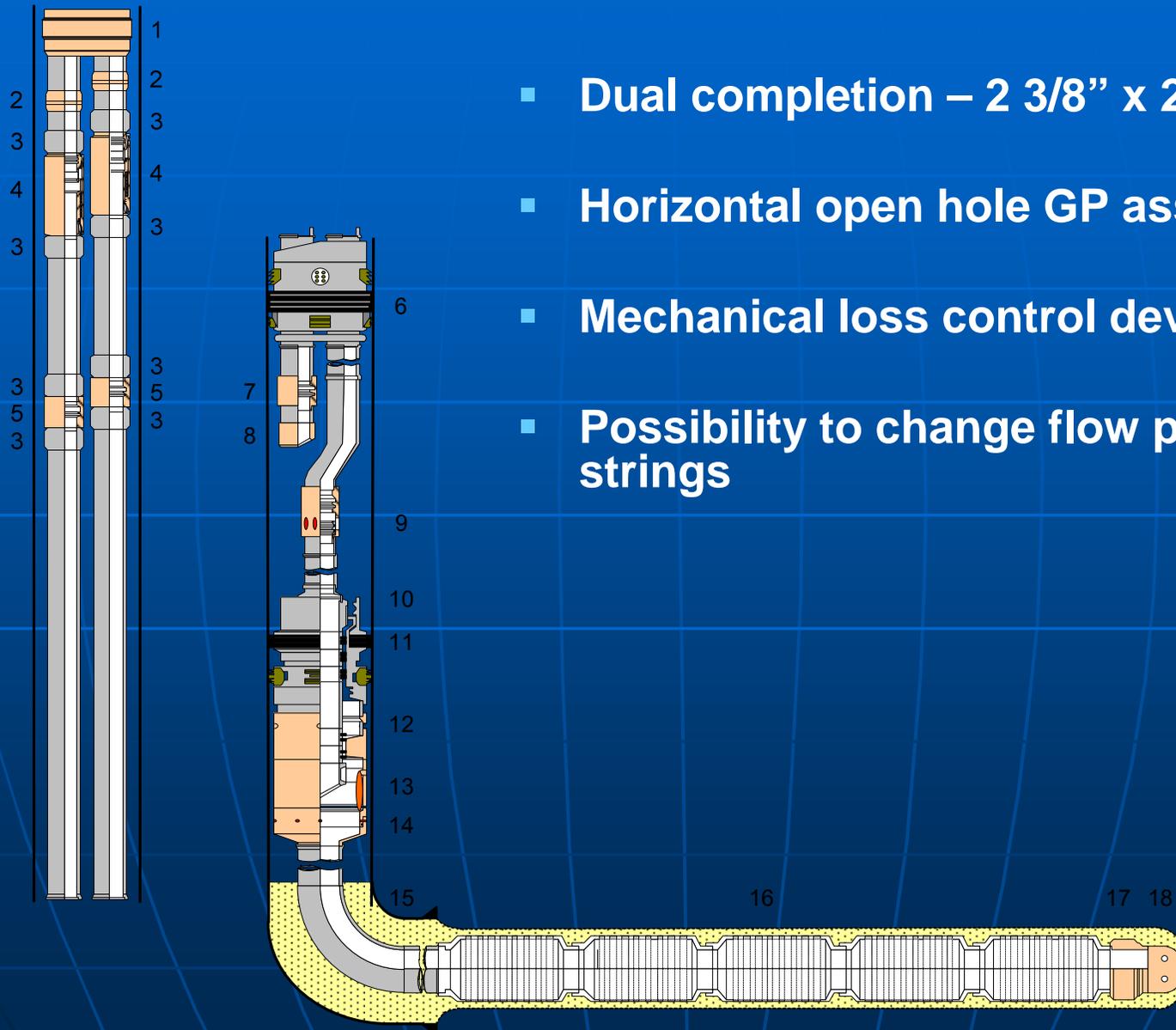


IKA A-2 HOR WELL



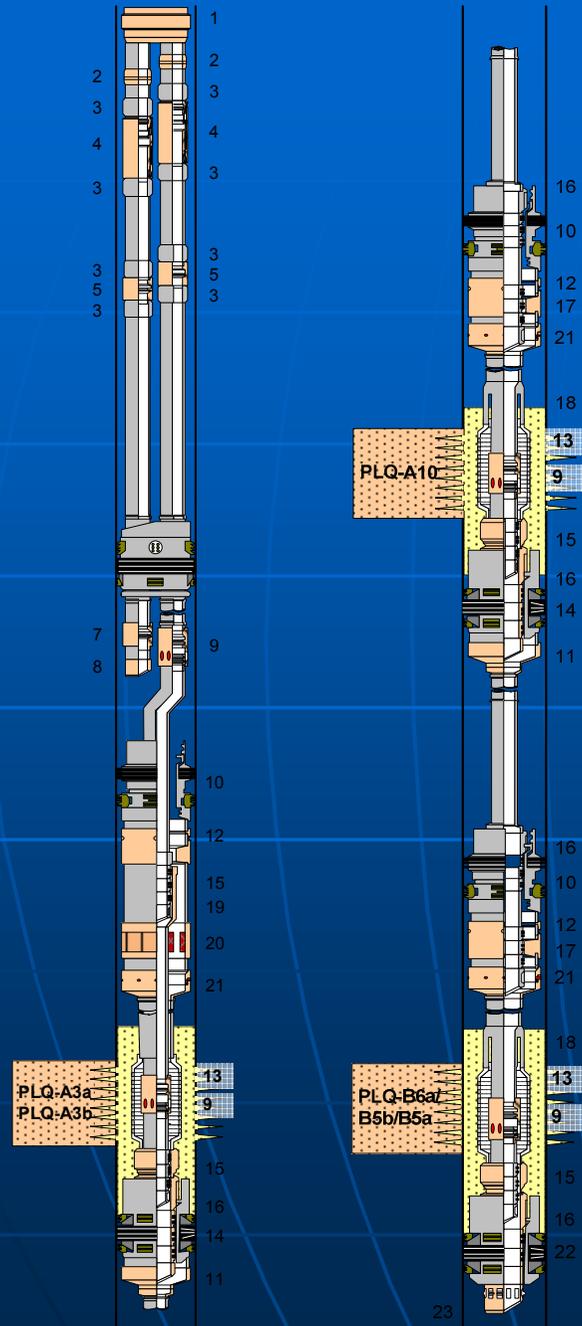
- Dual completion – 2 3/8" x 2 3/8" tubing; 2 3/8" GP assy
- Possibility to change flow path in both ways (2 dual packers)
- Long string selective completion
- Three zone multizonal system (PLQ-D1 – PLQ-C1 – PLQ-B3)
- Two zone multizonal system (PLQ-B1 – PLQ-A7)

KATARINA - 1 HOR WELL



- Dual completion – 2 3/8” x 2 3/8” tubing;
- Horizontal open hole GP assy.
- Mechanical loss control device
- Possibility to change flow path in both strings

ANNAMARIA - 3 DIR WELL



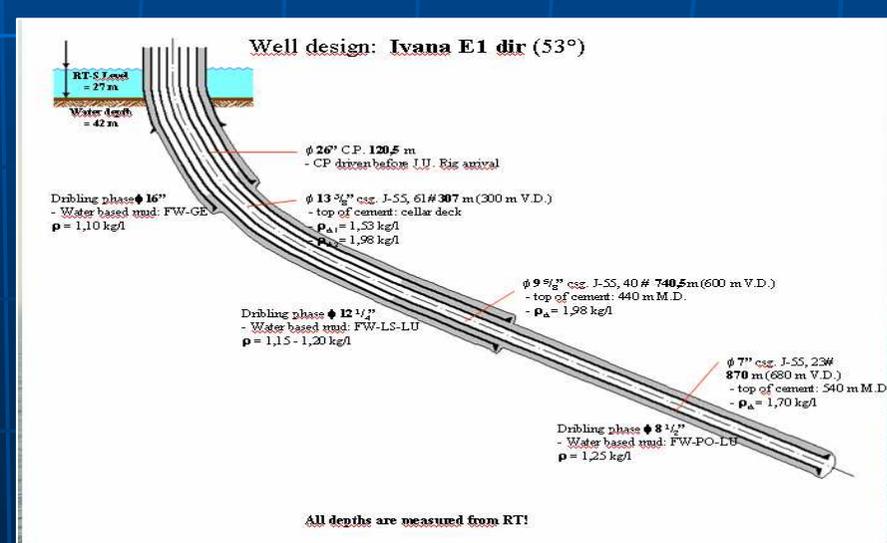
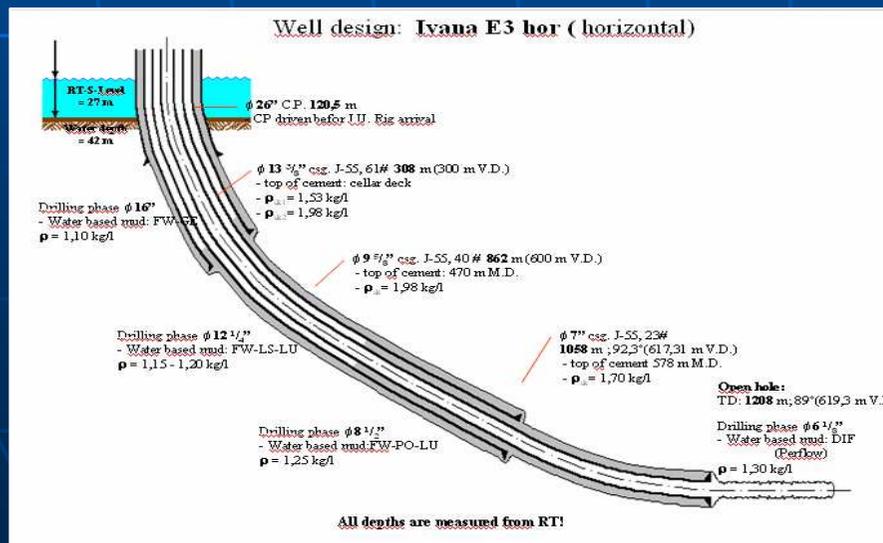
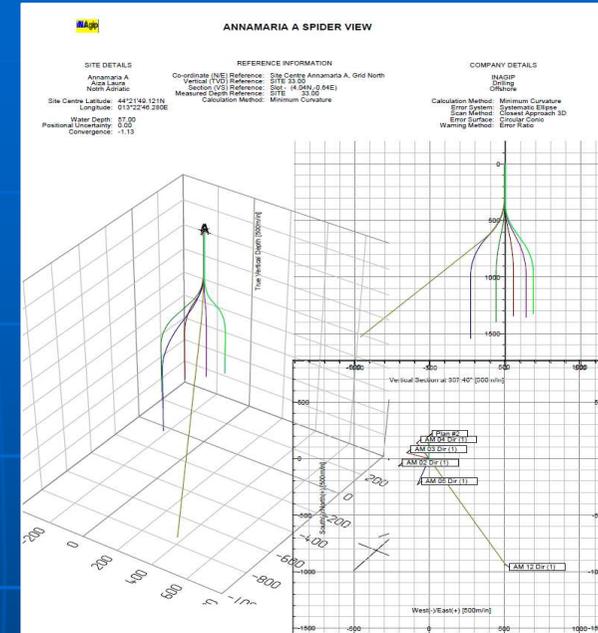
- Dual completion –2 3/8” x 2 3/8” tubing
- 2 double pin sub GP assy.
- 2 spacers
- Long string selective completion
- F&P + 2 HRWP
- Mechanical annular loss control valve (SAF)

WELL CLEANING & TESTING

- After well completion tubing string had been pickled from the rust or grease using CT
- Layers were tested selectively manipulating w/ ssd, recording pressure and temperature on the surface and downhole for the carbonate reservoir
- In cases where lcm pills were spotted in front of the screens because of the losses after gravel packing, acid job before testing was performed w/ 10% HCOOH
- Results obtained from back surging (before sand control) represents real reservoir characteristic
- Results obtained from clean-up (after sand control) is characterized by lower productivity due to enormous loss of completion fluid, but with its fast recovery

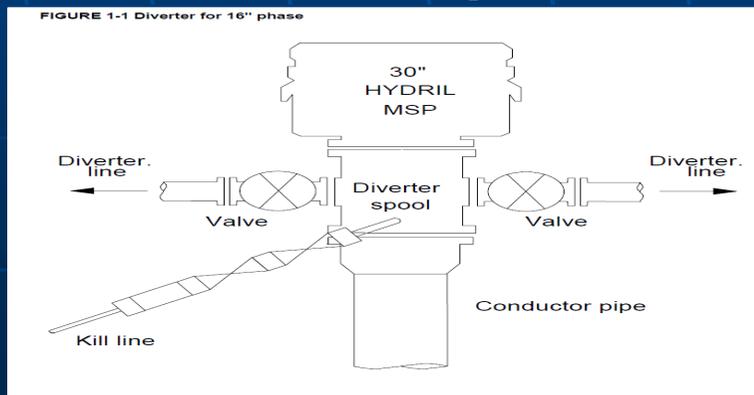
INA OFFSHORE WELL CONTROL ISSUES

- Shallow gas policy
- Diverter configuration
- Kick tolerance, Choke margin
- Mud design, Cement slurry design
- BOP configurations for drilling & completion
- Well head – compact / X- mass tree (dual string)
- Well control procedure
- P&A of exploration wells



SHALLOW GAS POLICY / DIVERTER

- For unknown area, sample coring within site survey, in pre phase is required to verify geomechanical mud line properties (for aft. legs penetration requirements)
- Exploration well / production platform position to avoid shallow gas - high amplitude anomalies up to 300m TVD; shallow seismic is mandatory;
- Conductor pipes 30" (for expl. wells) & 26" / 22" for production wells are required to be driven up to 30 – 50 m in mud line;
- In case of medium ampl. anomalies, pilot drilling \varnothing 8 1/2" (prior drilling first hole of 16")
- Drilling phase \varnothing 16" w/Diverter system WP 1000/500 psi / 12" two lines w/hydr./pneum. valves; kill mud 1,4 kg/l in stand by
- Mud losses usually occurred below CP shoe (cement plug jobs)



KICK TOLERANCE / CHOKE MARGIN / MUD WEIGHT

■ Kick tolerance- calculator: bar/10m

- Hole Ø 12 ¼" : max 11 m³
- Hole Ø 8 ½" : max 13 m³
- Hole Ø 6" : max 16 m³

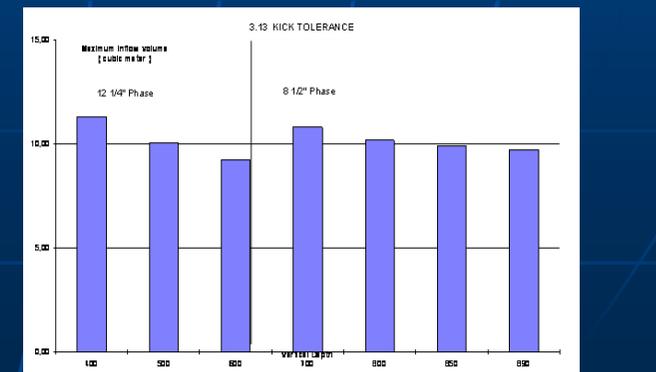
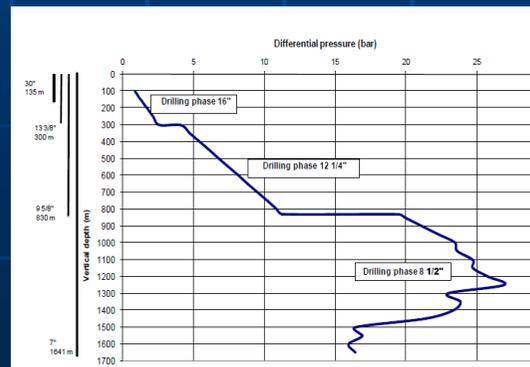
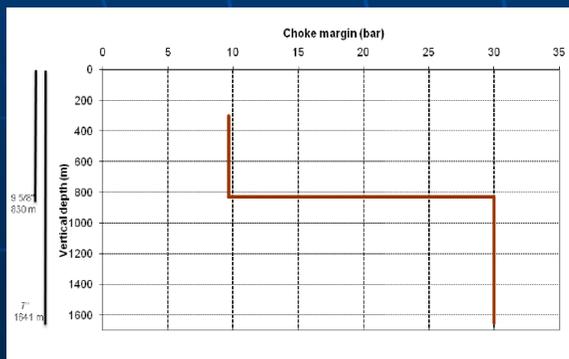
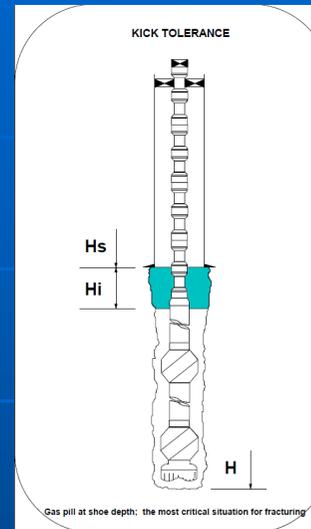
■ Choke margin:

- Hole Ø12 ¼" : min 10 bar
- Hole Ø 8 ½" : min 30 bar
- Hole Ø 6" : min 60 bar

■ Mud design:

- Hole Ø16": FW-GE; 1,10 kg/l ; P dif cca 5 bar
- Hole Ø12 ¼": FW-LS-LU; 1,15 kg/l; Pdif cca 11 bar
- Hole Ø 8 ½": FW-PO-LU; 1,25 kg/l / reservoir drilling; Pdif up to 25 bar
- Hole Ø 6": DIF; 1,25 kg/l / reservoir drilling / open hole-horiz.; Pdif up to 25 bar

General: PPG=1,03-1,16



CEMENT SLURRY DESIGN

- **Casing 13 3/8" up to 300m RT-VD:**
 - For exploration well: TOC to cca 5 m below mud line; Lead cs = 1,53 kg/l / Tail cs = 1,98 kg/l (sea water)
 - For production well: TOC to top of Cellar Deck ; same as a.m.
- **Casing 9 5/8" cca 600 – 800 m RT-VD:**
 - For exploration/production wells TOC up to 200m in previous csg;
 - Lead cs = 1,50 kg/l / Tail cs = 1,80 kg/l ; 3% Microsilica (sea water);
- **Casing 7" cca 700 – 1700 m RT- VD:**
 - For exploration/production wells TOC up to 200m in previous csg;
 - Lead cs = 1,70 kg/l ; 10% Microsilica (fresh water)

Annmaria 5 Dir **13 3/8" casing cement job @ m 290 MD**
Top cement @ Cellar Deck

Casing Equipment

Spacing	from m	to m	Centraliz.	type	Stop Coll.	scratchers
C1	140	15	welded blades = 3 pcs			
TOTAL			3			0

Shoe type stab in

VOLUMES

	inside	outside	l/m	m	Volume
Annulus	26"	13 3/8"	201,06	125	m ³ 25,1
Annulus	16"	13 3/8"	39,2	150	m ³ 5,9
Annulus					m ³ 0
Annular excess			150	%	m ³ 8,8
TOTAL VOLUME					m³ 39,8

SLURRY "A" VOLUME **26,6**

Slurry SG = 1,53 Kgl

	G	q/m ³	7,1 x	m ³	26,6	q	189
CEMENT							
BENTONITE		8,0	% b.w.o.c				15,1
SEA WATER		l/q	100,0 x	q	189	m ³	20

SLURRY "B" VOLUME **13,3**

Slurry SG = 1,98 Kgl

	G	q/m ³	14,0 x	m ³	13,3	q	186
CEMENT							
SEA WATER		l/q	40,0 x	q	186	m ³	7

NOTE: Use thread lock compound on the first two joint
 Program remedial job with tbg from top in case of TOC lower than programmed
 "B" type Slurry : Thickening time = 120-160 min @ 30°C (BHST)

Annmaria 5 Dir **9 5/8" casing cement job @ 1056 m MD (1000 m VD)**
Top cement @ 190 m MD (190 m VD)

Casing Equipment

Spacing	from m	to m	Centraliz.	type	Stop Coll.	Scratchers
C1	1056	190	64	RIGID-	128	
				SPIRAL		
TOTAL			64		128	0

Shoe and Collar type : Not Rotating, Shoe-Collar at 2 joint
 Bottom and Top Plug type : Not Rotating PDC Drillable

VOLUMES

	inside	outside	l/m	m	Volume
Annulus	13 3/8"	9 5/8"	32,27	100	m ³ 3,2
Annulus	12 1/4"	9 5/8"	28,83	766	m ³ 22,2
Shoe-collar at 2 joint			38,85	28	m ³ 1,1
Annular Excess			30	%	m ³ 6,6
TOTAL VOLUME					m³ 33,1

SLURRY "A" VOLUME **22,1**

Slurry SG = 1,6 Kgl

	G	q/m ³	6,8 x	m ³	22,1	q	150
CEMENT							
SEA WATER		l/q	115,0 x	q	150	m ³	17

SLURRY "B" VOLUME **11,0**

Slurry SG = 1,8 Kgl

	G	q/m ³	11,6 x	m ³	11,0	q	127
CEMENT							
SEA WATER		l/q	92,6 x	q	127	m ³	7

Fracture Press. kg/cm²/10m 1,64 1000 bar 164
 Hydr. P end displ. (1,87250+1,97550+1*100+1,15*100)/10 bar 149
 Formation Press. kg/cm²/10m 1,03 x m 1000 bar 103
 Hydr. P during WOC (1*800+1*100+1,15*100)/10 bar 102

Underbalance during W.O.C. of 2 bar
 Minimum Fracture Margin at TD 15 bar

Fracture Gradient on bottom 1,64 bar/10m
 Annulus Gradient at the end of displacement 1,49 bar/10m
 Gradient during W.O.C. 1,02 bar/10m
 Estimated Pore Gradient 1,03 bar/10m

NOTE: Use thread lock compound on the first 3 joints. Thickening time ~ 180 min at 30°C (BHST)
 W.O.C. = 8 - 9 hours

Annmaria 5 Dir **7" casing cement job @ 1585 m MD (1528 m VD)**
Top cement @ 856 m MD (800 m VD)

Casing Equipment

Spacing	from m	to m	Centraliz.	type	Stop Coll.	Scratchers
C1	1585	856	54	RIGID-	108	
				SPIRAL		
TOTAL			54		108	0

Shoe and Collar type : Conventional, Shoe-Collar at 3 joints

VOLUMES

	inside	outside	l/m	m	Volume
Annulus	9 5/8"	7"	13,97	200	m ³ 2,8
Annulus	8 1/2"	7"	11,73	529	m ³ 6,2
Shoe-collar at 3 joint			20,53	41	m ³ 0,8
Annular Excess			26	%	m ³ 1,6
TOTAL VOLUME					m³ 11,4

TOTAL SLURRY VOLUME **11,4**

Slurry SG = 1,7 Kgl - 10% MICROSILICA

	G	q/m ³	9,6 x	m ³	11,4	q	109
CEMENT							
FRESH WATER		l/q	72,0 x	q	109	m ³	7,9

Fracture Press. kg/cm²/10m 1,74 1528 bar 266
 Hydr. P end displ. (1,7728+1,5*200+1,25*600)/10 bar 229
 Formation Press. kg/cm²/10m 1,03 x m 1528 bar 157
 Hydr. P during WOC (1*728+1,5*200+1,25*600)/10 bar 178

Overbalance during W.O.C. 20 bar
 Minimum Fracture Margin at TD 37 bar

NOTE: Use thread lock compound on the first 4 joints. Thickening time ~ 220-240 min at 30°C (BHST)
 W.O.C. = 12-14 hours
 Fracture Gradient on bottom 1,74 bar/10m
 Annulus Gradient at the end of displacement 1,50 bar/10m
 Gradient during W.O.C. 1,16 bar/10m
 Estimated Pore Gradient 1,03 bar/10m

BOP CONFIGURATION

In Drilling mode:

- One Bag type preventer – 5M
- For Ram preventers (two double) – 10M
 - Upper Pipe Rams : Variable 4" - 7"
 - Blind/Shear Rams
 - Lower Pipe Rams (1) : 2 7/8" – 5"
 - Lower Pipe Rams (2) : 5"

In Completion mode:

- One Bag type preventer – 5M
- For Ram preventers (two double) – 10M
 - Upper Pipe Rams : Centralizing
 - Blind/Shear Rams
 - Lower Pipe Rams (1) : 2 3/8" – 3 1/2"
 - Lower Pipe Rams (2) : Dual 2 3/8"

BOP test :

- prior Drilling operations
- on WH installation
- every 14 days

- Accumulator Unit WP 3000 PSI, to meet requirement a.m. BOP configuration; function test; 2 remote panels (rig floor & rig supt. office)

Casing test:

- Bump plug at the end of cementing job
- After WH installation w/BOP test

FIGURE 1-3 BOP Stack for 12 1/4" and 8 1/2" phase

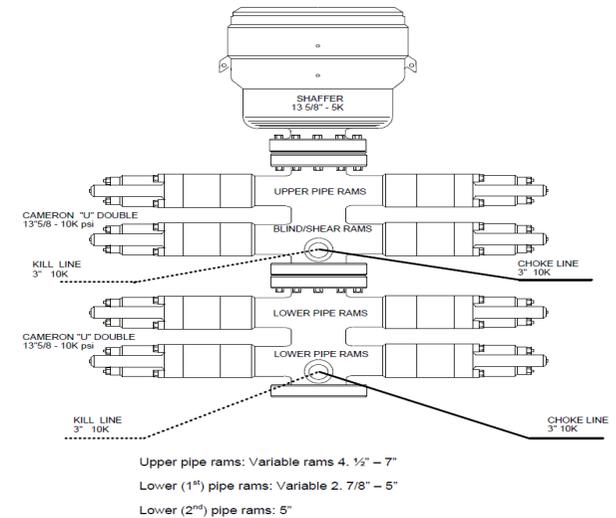
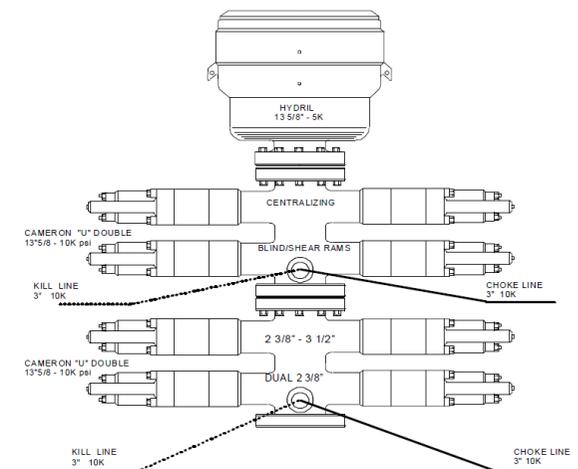
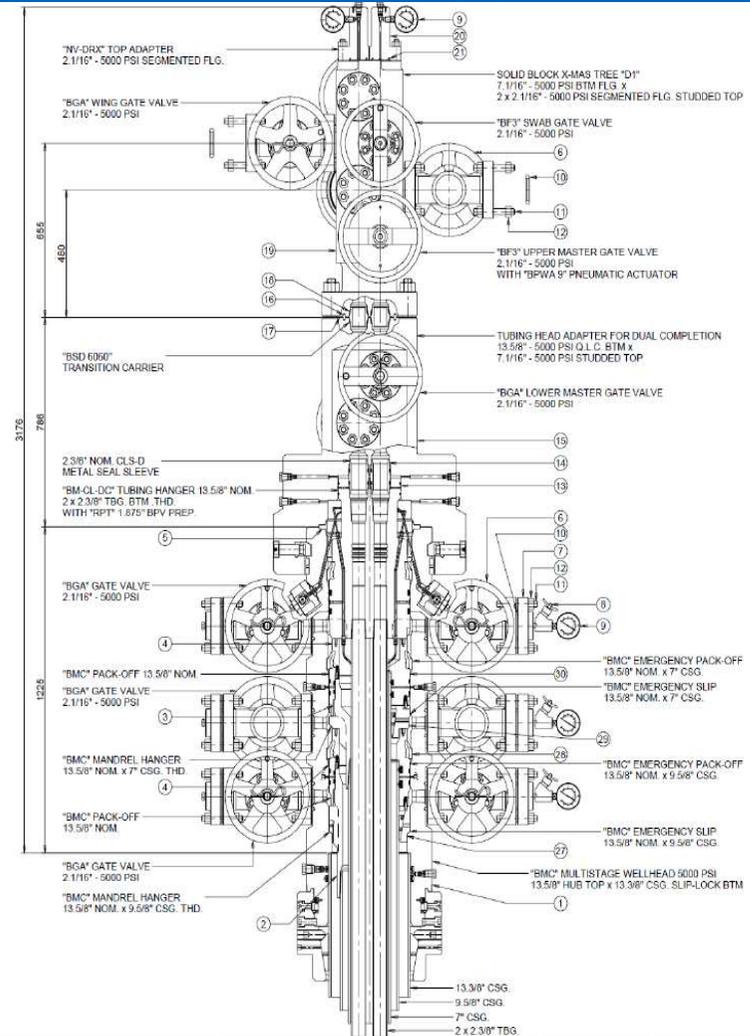
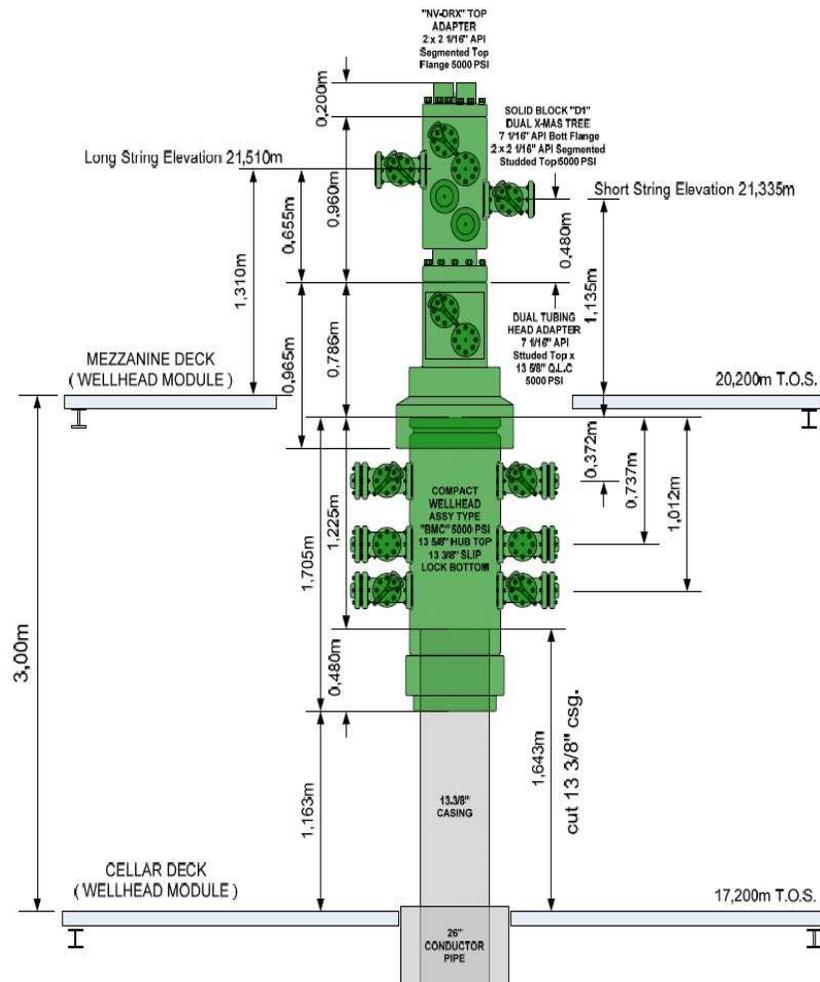


FIGURE 4-1 Bop arrangement during completion phase



WELL HEAD – COMPACT / X-MAS TREE (DUAL STRING)

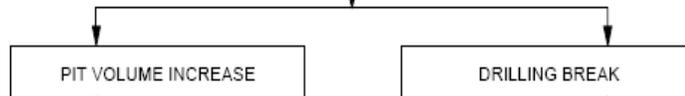
FIGURE 3-28 Annamaria A platform wellhead and x-mass tree configuration



WELL CONTROL PROCEDURE

HARD SHUT-IN PROCEDURES

WHILE DRILLING



- STOP DRILLING
- RAISE KELLY OR TOP DRIVE
- STOP PUMP
- CHECK FOR FLOW
- NOTIFY DRILLING CONTRACTOR AND COMPANY REPRESENTATIVES

THE WELL FLOWS

- CLOSE ANNULAR BOP
- CHECK CHOKE POSITION (CLOSED)
- IF NEEDED, CLOSE THE APPROPRIATE PIPE RAMS
- OPEN THE HYDRAULIC OPERATED VALVE (HCR) ON CHOKE LINE
- RECORD TIME, *SIDPP* AND *SICP*
- KICK VOLUME (PIT GAIN)
- PREPARE FOR KILLING OPERATIONS

THE WELL DOESN'T FLOW

- CIRCULATE BOTTOMS UP TO ANALYSE MUD PROPERTIES AND DRILLED CUTTINGS
- IF DRILLING IS RESUMED CHECK PIT LEVEL CAREFULLY

HARD SHUT-IN PROCEDURES

WHILE TRIPPING DP/DC OR A LINER LANDING STRING

THE MUD VOLUME IN TRIP TANK IS DIFFERENT FROM THE STEEL VOLUME OF PIPE PULLED OUT OF OR RUN IN HOLE

- STOP TRIPPING (BE SURE THAT NO TOOL JOINT IS OPPOSITE ANY OF THE RAMS IN THE BOP STACK)
- NOTIFY DRILLING CONTRACTOR AND COMPANY REPRESENTATIVES

THE WELL DOESN'T FLOW

- RUN PIPES BACK TO BOTTOM
- RECHECK FOR FLOW

THE WELL DOESN'T FLOW

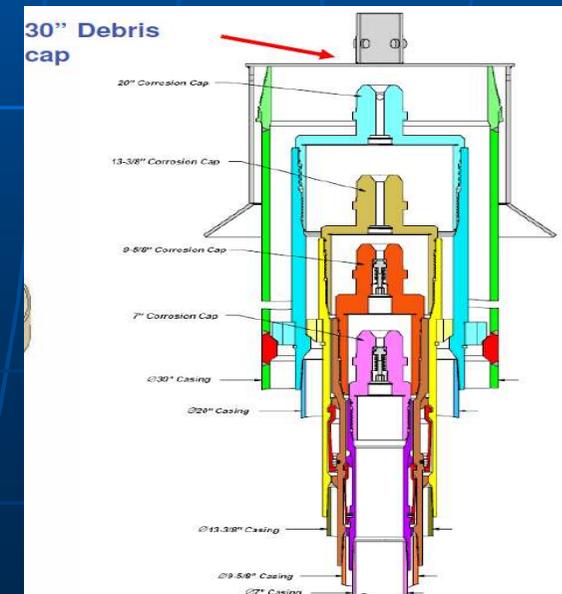
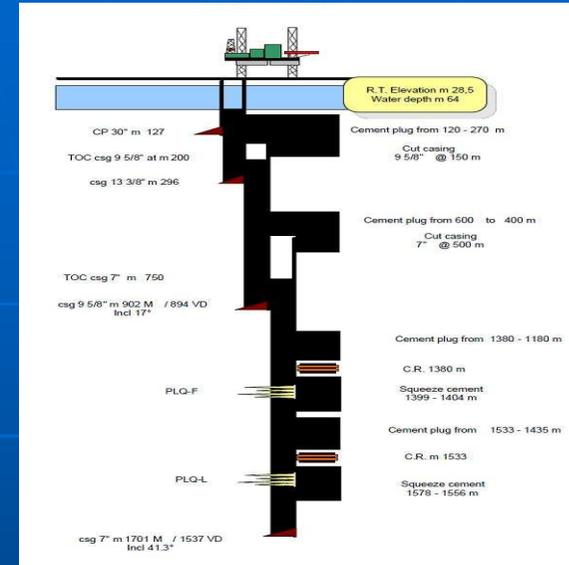
- CIRCULATE BOTTOMS UP AT NORMAL FLOW RATE WITH BOP OPENED. CHECK CAREFULLY PIT LEVEL

THE WELL FLOW

- INSTALL THE STAND-BY FULL OPEN SAFETY VALVE (KELLY COCK)
- CLOSE KELLY COCK
- OPEN VALVE ON CHOKE LINE
- CLOSE ANNULAR BOP
- CHECK CHOKE POSITION (CLOSED)
- IF NEEDED, CLOSE APPROPRIATE PIPE RAMS
- OPEN THE HYDRAULIC OPERATED VALVE (HCR) ON CHOKE LINE
- IF THE POWER CHOKE IN USE IS NOT A POSITIVE SEAL CHOKE, CLOSE MANUAL VALVE BEHIND CHOKE
- RECORD TIME, *SICP*, AND KICK VOLUME (PIT GAIN)
- INSTAL TOP DRIVE OR KELLY AND PRESSURE TEST
- OPEN THE KELLY COCK
- RECORD *SIDPP*
- PREPARE TO KILL THE WELL

P & A – EXPLORATION WELLS

- **Abandoning at the end of Drilling in case of dry well (OH) (Permanent)**
 - Cover all permeable zones in OH (\varnothing 8 1/2") w/cement plug
 - Set cement plug 150-200m above 9 5/8" csg shoe
 - Cut 9 5/8" csg above TOC or 150m b. m.l.;
 - Set surface cement plug : 320-120m
 - Replace mud w/sea water
 - Cut 13 3/8" & 30" CP cca 2-3m below mud line
- **Abandoning tested levels in 7" csg:**
 - For each tested level, set cement retainer & squeeze cement in perfs, set cement plug above cca 150m;
 - Cut 7" csg above TOC; set cement plug cca 200m, overlapping 7" csg & 9 5/8" csg per 100m;
 - Same as a.m.
- **In case of MLS /Mud Line Suspension) : Temporary**
 - Each tested interval : Bridge plug & Cement plug above cca 150m;
 - Set cement plug within 7" csg cca 150-200m;
 - Back off & POOH the MLS running tool 7" csg & RIH corrosion cap;
 - Back off & POOH the MLS running tool 9 5/8" csg & RIH corrosion cap;
 - Back off & POOH the MLS running tool 13 3/8" csg & RIH corrosion cap;
 - Back off / Cut cca 2-3 m above m.l. & POOH the MLS running tool 30" CP & RIH debris cap



CROATIAN OFFSHORE SAFETY REGULATIONS FOR DRILLING & COMPLETION OPERATIONS

“ Regulations on main technical requirements,safety and protection during exploration and production of liquid and gaseous hydrocarbons from Croatian Offshore” ; “Official Gazette” 05/10; 2nd edition

GENERAL FROM AUTHORITY APPROVAL :

- **Main Mining Project for Offshore Drilling Rig by INA**
- **Main Mining Project for Well Operations by INA**
- **Environmental Impact Study by INA**
- **Concession licenses**
- **Well location permit**

OPERATING COMPANY:

- **Simplified Technical Project (Geological, Drilling, Well testing / Completion Programs)**
- **Emergency Response Plan (consider all Safety & HSE aspects for drilling & completion operations)**
- **All relations w/local marine authority**
- **Drilling & Completion Fundamental, Policies, Guidelines (Manual)**
- **Strictly follows Croatian Offshore Regulations**

DRILLING CONTRACTOR COMPANY:

- **Offshore Drilling Rig Safety Manual (fulfill all aspects of Safety & HSE procedures during drilling & completions operations)**
- **Strictly follows Croatian Offshore Regulations**

CONCLUSION

IN DRILLING:

- Batch mode drilling for rig time saving
- Suspension the exp. well at mud line for future tie-back and completion
- Water base mud (Poly, Drill in fluid) w/environmental friendly additives
- High sophisticated directional drilling tools (Steerable rotary drilling systems, PDM, MWD, LWD)
- Newest generation of logging tools

IN COMPLETION:

- Dual completion system
- Carbonate isolation system (tail completion vs. upper sand layers to be completed)
- Gravel pack technique: horizontal OH, HRWP, Frack & Pack
- Multizonal gravel pack tool (mini beta system)
- Fluid loss control using double pin sub completion technique (long string) and SAF valve (short string)

...CONCLUSION

OVERALL:

- According to the well test results, all expected start-up gas rate per wells have been achieved
- Improvement of well productivity expected in first few months of production
- Ultimate recovery has increased as a function of number of developed reservoirs due to applied modern well technology
- In the same time, number of required wells enabled optimizing number and design of production platforms



***THANK YOU FOR
ATTENDANCE!***

Questions?