WellCAP®
IADC WELL CONTROL ACCREDITATION PROGRAM

WORKOVER & COMPLETION OPERATIONS
CORE CURRICULUM AND RELATED JOB SKILLS
FORM WCT-2WF

FUNDAMENTAL LEVEL

The purpose of the core curriculum is to identify a body of knowledge and a set of job skills which can be used to provide well control skills for workover operations (including well testing and initial completion). The curriculum is divided into three course levels: Introductory, Fundamental, and Supervisory.

The suggested target students for each core curriculum level are as follows:

INTRODUCTORY: Floorhand, Derrickman
(May also be appropriate for non-technical personnel)

FUNDAMENTAL: Derrickman, Assistant Driller, and Driller

SUPERVISORY: Toolpusher, Superintendent, and Drilling Foreman

Upon completion of a well control training course base on curriculum guidelines, the student should be able to perform the job skills in italics identified by a "■" mark (e.g., ■ *Identify causes of kicks*).

TABLE OF CONTENTS

I. REASONS FOR WELL-COMPLETIONS AND WELL-WORKOVER OPERATIONS

TRAINING TOPICS	*JOB SKILLS*
A. Definitions of well-completions operations	■ *Describe well-completion operations.*
B. Definition of well-workover operations	■ *Describe well-workover operations.*
C. Reasons for completion/workover operations which may include:	■ *Identify reasons for working over a well.*
1. Completing for production from a new reservoir.	■ *List potential well control problems that could occur during workover operations.*
2. Completing a well in more than one reservoir.	
3. Stimulating a completion in a producing reservoir.	
4. Reworking a producing reservoir to control water and/or gas production.	
5. Rework to reduce or eliminate water coning.	
6. Repair mechanical failure.	
7. Cement repair.	

II. DEFINITIONS AND CALCULATIONS

TRAINING TOPICS	*JOB SKILLS*
A. Pressure fundamentals 1. Definition of pressure a. Force b. Area 2. Types of pressure a. Pressure gradient 1) Liquid 2) Gas b. Hydrostatic pressure 1) General 2) Effect of fluid level change c. Total downhole pressure 1) Considering multiple fluid columns with varying densities 2) Considering shut-in surface pressures d. Bottomhole pressure e. Formation pressure 1) Balanced 2) Underbalanced 3) Overbalanced f. Differential pressure g. Trapped pressure h. Swab pressure i. Surge pressure j. Fracture pressure k. Circulating frictional pressure losses	■ *Define the following items:* • Force • Pressure gradient • Hydrostatic pressure • Bottomhole pressure • Differential pressure • Total downhole pressure • Formation pressure ■ *Calculate the above pressures.* ■ *Calculate effect of surface pressure on downhole pressures.* ■ *Demonstrate understanding of U-tube concept.* ■ *Calculate hydrostatic changes due to fluid level changes.* ■ *Calculate fluid column height to generate a specific hydrostatic pressure.* ■ *Explain causes and effects of swab and surge pressures in the wellbore.* ■ *Explain circulating frictional pressure losses and calculate effects on pressure and equivalent circulating density for forward and reverse circulation.* *Definitions and Calculations continued on next page.*

3. Equivalent static fluid density a. Definition b. Pressures expressed as an equivalent fluid weight 4. Equivalent circulating density a. Definition b. Frictional pressure loss effects on downhole pressure c. Surface pressure effects 5. U-tube principles	*Definitions and Calculations continued.*
B. Capacities/Displacements 1. Definition of displacement a. Tubulars 2. Definition of capacity a. Tubing b. Annulus c. Hole d. Fluid pit	■ *Define* • displacement • capacity ■ *Calculate* • capacity of wellbore, tubulars, annulus, etc. • displacement of tubulars, etc.
C. Force 1. Definition 2. Stripping (considering buoyed tubing weight) 3. Packer, plug, etc. (considering differential pressure across packer, plug, etc.)	■ *Define force and buoyancy.*

III. KICK FUNDAMENTALS

TRAINING TOPICS	*JOB SKILLS*
A. Definition of a kick	■ *Define a kick.*
B. Causes of kicks 1. Insufficient fluid density 2. Failure to keep hole full 3. Swabbing the well 4. Loss of circulation	■ *Identify causes of a kick..*
C. Kick detection 1. Kick indicators and warning signs including, but not limited to: a. Increase in return fluid flow rate b. Gain in pit volume c. Well flowing with pump shut down d. Decrease in pump pressure/increase in pump rate e. Hole not taking proper amount of fluid when pulling pipe f. Volume displacement change during trip in g. Surface pressures h. Change in string weight i. Oil or gas shows during circulation j. Trip, connection or background gas changes k. Changes in fluid properties	■ *Identify indicators and warning signs of a kick* ■ *Rank indicators from most reliable to least reliable.*

Kick Fundamentals continued on next page.

TRAINING TOPICS	*JOB SKILLS*
D. Importance of responding to kick indicators in a timely manner 1. Minimize kick volume 2. Consequences of not responding a. Kick becomes blowout b. Possible release of poisonous gases c. Pollution d. Potential for fire e. Loss of life, equipment resources f. Larger kick and higher shut-in surface pressure	■ *Identify the benefit of timely response to kick indicators.* ■ *Identify or describe potential consequences of improper or untimely response to kick indicators.*

IV. GAS CHARACTERISTICS AND BEHAVIOR

TRAINING TOPICS	*JOB SKILLS*
A. Pressure, volume, relationship (Boyles Law)	■ *Describe pressure and volume relationships for gas.* ■ *Calculate simple pressure-volume gas relationships.*
B. Gas expansion and migration relationships 1. In the wellbore a. Gas density based on pressure b. Effect on bottomhole pressure c. Effect on surface pressure d. Effect on uncontrolled pressure	■ *Describe the effects of gas migration (both expanded and unexpanded) on surface equipment and downhole pressures.*
C. Solubility of gases 1. Water based fluid 2. Oil based fluid 3. Effect on kick detection	■ *Describe the effects of gas solubility on the following:* • kick detection • gas flashing near surface

V. COMPLETION AND WORKOVER FLUIDS

TRAINING TOPICS	*JOB SKILLS*
A. Primary function is pressure control	■ *State the primary function of completion and workover fluids.*
B. Characteristics 1. Ability to control fluid loss	■ *Describe desirable properties of workover fluids.*
C. Fluid types 1. Oil and oil based fluids 2. Water and water based fluids a. Brines (selection based on density requirements) 3. Gases 4. Packer fluids 5. Other types	■ *Identify various fluid types and their relative densities.* ■ *Select brines to meet specific fluid density requirements.*

Completion and Workover Fluids continued on next page.

Completion and Workover Fluids continued

TRAINING TOPICS	*JOB SKILLS*
D. Fluid density concerns and measuring techniques 1. Mud balance 2. Pressurized mud balance 3. Effect of temperature 4. Settling of solids 5. Crystalization 6. Hydrates	■ *Using a mud balance, determine the density of a fluid.* ■ *Describe various techniques for measuring fluid density.* ■ *Determine fluid density changes due to temperature effects.*

VI. SURFACE EQUIPMENT

TRAINING TOPICS	*JOB SKILLS*
A. Christmas (Xmas) tree 1. Equipment a. Pressure gauges a. Gauge flange or cap b. Swab valve c. Flow or cross tee d. Wing valves e. Master valves f. Surface safety valves 2. Configuration	■ *Identify function and configuration of the key Xmas tree components.*
B. Blowout preventer stack 1. Equipment a. Annular preventers and strippers b. Rams 1) Blind 2) Pipe/Multiple string 3) Shear 4) Blind/Shear 5) Variable bore and slip c. Ram locking mechanisms d. Sealing elements e. Valves 2. Configuration	■ *Identify function and configuration of key BOP stack components.* ■ *Describe function of BOP closing and locking mechanisms.* ■ *Identify flow path(s) used in well control operations.* ■ *Identify locations for choke and kill line valves.*

Surface Equipment continued on next page.

Surface Equipment continued.

TRAINING TOPICS	*JOB SKILLS*
C. Auxiliary well control equipment 1. Kelly valves (kelly cock) 2. Full open safety valve a. Top drive valves b. Floor stabbing valves 3. Inside BOP	■ *Describe function and use of the following:* • kelly valve • full open safety valve • inside blowout preventer ■ *Describe location of the above when not in use.*
D. Accumulators 1. Usable fluid volume test 2. Closing time test 3. Accumulator pressure a. Pre-charge pressure b. Minimum system pressure c. Operating pressure d. Maximum system pressure 4. Adjustment of operating pressure a. Manifold pressure regulator b. Annular pressure regulator 5. Operating functions of the remote BOP control panel	■ *Demonstrate understanding of the accumulator system functions, including an explanation of the consequences of losing nitrogen pre-charge pressure.* ■ *Describe the reasons and procedure for a usable fluid volume test.* ■ *State, for a 3000-psig system (or 5000-psig system, if applicable), the following:* • pre-charge pressure • minimum system pressure • normal regulated operating pressure • maximum system pressure ■ *List two reasons for adjusting regulated annular operating pressure.* ■ *Demonstrate the ability to operate the BOP from the driller's and the remote control panels.*

Surface Equipment continued on next page.

Surface Equipment continued.

TRAINING TOPICS	*JOB SKILLS*
E. Chokes and choke manifolds 1. Fixed chokes 2. Manual adjustable chokes 3. Remote adjustable chokes and back-up systems 4. Choke manifolds	■ *Describe function and components of choke system.* ■ *Explain how back-up system(s) to remotely operated chokes work.*
F. Fluid measuring devices 1. Volume pumped a. Pump stroke counter b. Rate vs. time 2. Fluid flow indicators 3. Pit volume totalizer 4. Pit level indicator 5. Trip tank a. Gravity fed type b. Recirculating or continuous fill type	■ *Describe various fluid measuring devices and their uses:* • stroke counter • fluid flow • pit volume totalizer • pit level indicator • trip tank
G. Gas detection and handling systems 1. Gas detectors 2. Fluid-Gas separators 3. Degasser	■ *Describe functions of fluid-gas separators.* ■ *Describe function of degasser.*

Surface Equipment continued on next page.

Surface Equipment continued.

TRAINING TOPICS	*JOB SKILLS*
H. Lubricator/Stripper assemblies 1. Wireline 2. Coiled tubing	■ *Describe general functions of lubricators and strippers and their use.* ■ *Identify potential risks when using lubricators or strippers.* ■ *Calculate net forces associated with the use of lubricators and strippers.*

VII. SUBSURFACE EQUIPMENT

TRAINING TOPICS	*JOB SKILLS*
A. Workstring and production tubing 1. Ratings a. Burst b. Collapse 2. Washouts 3. Inside BOPs (IBOPs)	■ *Identify tubing ratings (burst and collapse).* ■ *Identify or troubleshoot possible tubing failure (washouts, etc.).* ■ *Indentify IBOP options and safety considerations for each.*
B. Completion equipment 1. Tubing hander 2. Surface controlled subsurface safety valves 3. Packers and bridge plugs 4. Landing nipples and bridge plugs 5. Sliding sleeve 6. Multiple completions	■ *Identify potential well control complications and solutions when running completion equipment.* ■ *Identify proper ram selection for multiple completions.*

VIII. PROCEDURES

TRAINING TOPICS	*JOB SKILLS*
A. Set/Check alarm limits 1. High and low pit level 2. Return flow sensor 3. Trip tank level 4. Others (H_2S and flammable/explosive gas sensors)	■ *Identify the need for and reasons for setting high and low pit volume levels.* ■ *Describe relationship of relative flow sensor to a possible kick situation.* ■ *Describe the purpose for and locations for H_2S and explosive mixture gas sensors.* ■ *Describe the use of a trip tank and how it can be used to identify possible kicks.*
B. Pre-recorded well information 1. Well configuration a. Top and bottom of perforations b. Packer/Tool locations c. Tubing dimensions, lengths and strengths 2. Maximum safe casing pressures a. Wellhead rating b. Casing burst rating c. Tubing collapse and burst ratings d. Production zone/perforations 3. Fluid density(ies) in well 4. Reservoir data a. Pore pressure b. Fracture pressure	■ *Demonstrate an ability to document pre-recorded data significant to well control situations (perforation interval, packer locations, tubing strengths, safe working pressures, etc.).*

Procedures continued on next page.

Procedures continued.

TRAINING TOPICS	*JOB SKILLS*
C. Flow checking after cementing 5. Normal flow back 6. Not normal flow back	■ *Identify signs of a kick via flow checks.* ■ *Recognize U-tube effect.*
D. Shut-in 1. Procedure (steps not necessarily in order) a. While on bottom 1) Individual responsibilities 2) Space out, including consequences of irregular tubular lengths 3) Shut pump off 4) Shut-in well 5) Notify supervisor b. While tripping 1) Individual responsibilities 2) Space out 3) Close off workstring given variety of tubulars in use 4) Shut-in well 5) Notify supervisor c. Other operations 2. Shut-in techniques a. Hard b. Soft	■ *Describe or demonstrate shut-in techniques (and sequence of execution).*

Procedures continued on next page.

Procedures continued.

TRAINING TOPICS	*JOB SKILLS*
E. Verification of shut-in 1. Annulus a. Through BOP b. At the flow line 2. Workstring a. Pump pressure relief valves b. Standpipe manifold c. Full opening safety valve 3. Wellhead/BOP/Xmas tree a. Casing valve b. Crown, wing, master valves, etc. 4. Manifold a. Manifold valves b. Choke(s) (manual and remote)	■ *Identify appropriate valves/BOP equipment that are to be closed to effect a proper shut-in.*

Procedures continued on next page.

Procedures continued.

TRAINING TOPICS	*JOB SKILLS*
F. Well monitoring during shut-in 1. Recordkeeping a. Time of shut-in b. Tubing and casing pressures 1) At initial shut-in 2) At regular intervals c. Estimate pit gain d. Pressure increase at surface and downhole due to: 1) Gas migration 2) Gas expansion e. Pressure between casing strings	■ *Explain or demonstrate recommended procedures to use for well monitoring during well shut-in.* ■ *Read, record and report well shut-in recordkeeping parameters.* ■ *Describe the effects of trapped pressure on wellbore pressure.* ■ *List two surface pressure distinctions or differences that may result from shutting-in on a gas vs. liquid kick of equivalent volume.* ■ *Demonstrate procedure for relieving trapped pressure without creating underbalance situation.* ■ *Perform choke manipulation to achieve specific pressure or volume objectives.* ■ *Identify two causes for pressure between strings.*

Procedures continued on next page.

Procedures continued.

TRAINING TOPICS	*JOB SKILLS*
G. Tripping 1. Procedure for keeping hole full a. Using rig pump b. Using trip tank (gravity fill) c. Using recirculating trip tank (continuous fill) 2. Methods of measuring and recording hole fill volumes (trip sheet) 3. Wet trip calculations (non open-ended) a. Return to fluid system b. No return to fluid system c. Hole fill-up volumes 4. Dry trip calculations (open-ended) a. Hole fill-up volumes	■ *Describe methods for filling hole during trips.* ■ *Calculate hole filling requirements when pulling pipe and displacement when running pipe.* ■ *Describe the use of a trip tank.*
H. Stripping operations 1. Line up for bleeding volume to stripping tank 2. Stripping procedure for BOP 3. Measurement of volumes bled from the well 4. Calculations relating volumes and pressure to be bled for a given number of tubing or workstring stands run in the hole 5. Stripping with or without volumetric control	■ *Describe purpose and procedure for stripping operations (with and without volumetric control).* ■ *Demonstrate ability to line up to stripping tank.* ■ *Demonstrate sequence of BOP/rams when stripping.*
I. Well control drills 1. Pit drill 2. Trip drill	■ *Describe the purpose for pit and trip drills, etc.* ■ *Describe procedure for pit and trip drills and proper response to each.*

IX. WELL CONTROL TECHNIQES FOR KILLING A PRODUCING OR FLOWING WELL PRIOR TO OR DURING WELL COMPLETION OR WELL WORKOVER OPERATIONS

TRAINING TOPICS	*JOB SKILLS*
A. Objectives of well control techniqes 1. Circulate formation fluid out of well or back into formation 2. Re-establish primary well control by restoring hydrostatic balance 3. Avoid additional kicks 4. Avoid excessive surface and downhole pressures so as not to induce an underground blowout	■ *List objectives of well control techniques.*
B. Techniques for controlling or killing a producing well 1. Bullheading 2. Lubricate and bleed 3. Constant bottomhole pressure (BHP) techniques a. Wait and weight b. Drillers's method 4. Reverse circulate	■ *Describe a technique for controlling or killing a producing well.*

Well Control Techniques (Producing or Flowing Well) continued on next page.

Well Control Techniques (Producing or Flowing Well) continued.

TRAINING TOPICS	*JOB SKILLS*
C. Preparing for well entry 1. Use of back pressure valves 2. Us of valve removal plug (VR plug) 3. Surface and subsurface safety systems 4. Removal of tree and tubing hanger 5. Installation and testing of BOP and wellhead prior to removal of back pressure valves and tubing plugs	■ *Describe procedure for preparing for well entry.* ■ *List two safety concerns and well control considerations when removing a VR plug.* ■ *List three safety concerns and well control considerations when removing a tree and tubing hanger.* ■ *Describe reasons for and use of back pressure valves and surface and subsurface safety systems.* ■ *Describe procedure for installing and testing of BOP and wellhead prior to removal of back pressure valves and tubing plugs.*

X. WELL CONTROL TECHNIQUES

TRAINING TOPICS	*JOB SKILLS*
A. No returns pumping technique (e.g., bullheading) 1. Well shut-in will stop influx when BHP equals formation pressure 2. Determine status of shut-in tubing pressure (SITP), shut-in casing pressure (SICP) 3. Pump rates and pressure limitations a. Maximum pump pressure b. Friction of fluids vs. rate c. Gain in hydrostatic pressure vs. volume pumped d. Burst pressure of tubulars e. Collapse pressure of tubulars f. Formation fracture pressure 4. Determine volume to be pumped a. Theoretical volume to formation b. Overdisplacement (if any) c. Volume to pump to load surface lines 5. Pump rate vs. volume pumped 6. Gas migration vs. pumped fluid viscosity 7. Determine if well has been successfully killed 8. Barrier concept	■ *Demonstrate bullheading technique when applicable.* ■ *Monitor and record pressure.* ■ *Select appropriate pump rates.* ■ *Calculate maximum pressures.* ■ *Calculate volumes.* ■ *Discuss effect of gas migration vs. kill attempt.* ■ *Check pressures to verify if well has been successfully killed.* ■ *Explain barrier concept and give four examples.*

Well Control Techniques continued on next page.

Well Control Techniques continued.

TRAINING TOPICS	*JOB SKILLS*
B. Volumetric techniques and lubricte and bleed	■ *Demonstrate a volumetric well control technique.*
1. Fluid pressure/volume relationship	
2. Pressure to maintain vs. fluid lost or added	
3. Safety margin, working margin and minimum pressures	
C. Constant bottomhole pressure (BHP) methods (forward or reverse circulation)	■ *Demonstrate a constant bottomhole pressure (BHP) technique.*
1. Well shut-in will stop influx when BHP equals formation pressure	■ *Explain how pump/choke manipulation relates to maintaining BHP.*
2. Circulating out a kick with choke back pressure to keep BHP equal to or slightly greater than formation pressure	
3. Bottom of the workstring must be at the kicking formation (or bottom of the well) to effectively kill the kick and be able to resume normal operations	

Well Control Techniques continued on next page.

Well Control Techniques continued.

TRAINING TOPICS	***JOB SKILLS***
D. Preparation of well control kill worksheet 1. Well control calculations a. Tubing and annular volumes, strokes/volume and times b. Fluid density increase required to balance formation pressure c. Initial and final circulating pressure as appropriate for methods taught 2. Maximum wellbore pressure limitations a. Surface b. Subsurface 3. Selection of pump rate a. Allowing for friction losses b. Choke operator reaction time c. Pump limitations	■ *Prepare a well control worksheet for killing a well:* • calculate tubing and annulus volumes • determine fluid density increase (if required) • calculate total strokes/volume to circulate the well and time required (as appropriate) ■ *Identify wellbore pressure limitations and list consequences of exceeding pressure limitations identified.* ■ *Select pump rate, considering frictional losses, choke operator reaction time, pump limitations, etc.*

Well Control Techniques continued on next page.

Well Control Techniques continued.

TRAINING TOPICS	*JOB SKILLS*
E. Well control procedures 1. Procedure to bring pump on and off line and change pump speed while holding BHP constant using the choke a. Use of casing pressure gauge b. Lag time response on standpipe pressure gauge 2. Procedure for determining initial circulating pressure a. Using recorded shut-in tubing pressure and reduced circulating pressure b. Without a pre-recorded value for reduced circulating pressure c. Adjustment for difference in observed vs. calculated circulating pressures 3. Choke adjustment during well kill operations a. Changes in surface pressure as a result of changes in hydrostatic head or circulating rates 1) Drop in pump pressure as fluid density increases in tubing during well control operations 2) Increase in pump pressure with increased pump rate and vice versa b. Changes in casing pressure during well control operations 1) Adjustments due to fluid velocity changes across the choke 2) Adjustments due to fluid density change c. Pressure response time 1) Casing pressure gauge (immediate) 2) Drill pipe pressure gauge (lag time)	■ *Demonstrate the ability to bring pump on and off line using the casing or annulus gauge.* ■ *Demonstrate an ability to establish correct initial circulating pressure.* ■ *Demonstrate obtaining an initial circulating pressure without a pre-recorded reduced circulating pressure.* ■ *Demonstrate the ability to control pressures using a choke while maintaining a constant pump speed.* ■ *Demonstrate the ability to follow the constant bottomhole pressure well control plan using the pump and choke.*

XI. COMPLICATIONS AND SOLUTIONS

TRAINING TOPICS	*JOB SKILLS*
A. Trapped pressure 1. Wireline plugs 2. Subsurface safety valves (storm chokes) 3. Surface controlled subsurface safety valve 4. Bridge plugs 5. Sand bridges 6. Paraffin 7. Hydrates 8. Beneath packer	■ *Identify sources of potential trapped pressure.* ■ *Describe procedure for resolving sources identified at left.*
B. Pressure on casing 1. Hole in tubing 2. Hole in casing 3. Seal or packer leak. 4. Pressure or temperature pulled seals out of seal bore 5. Failed squeeze job or patch	■ *Identify sources of pressure on casing and explain the well control implications.*
C. Underground flow	■ *Based on surface parameters, identify underground flow and possible solutions.*
D. Cannot circulate well (i.e., plugged workstring, etc.)	■ *List three reasons why a well cannot be circulated and a solution for each.*

Complications and Solutions continued on next page.

Complications and Solutions continued.

TRAINING TOPICS	*JOB SKILLS*
E. Hydrates	■ *Describe the possible effects of hydrates on well control.*
F. Lost circulation	■ *Identify signs of lost circulation.*

XII. ORGANIZING A WELL KILL OPERATION

TRAINING TOPICS	*JOB SKILLS*
A. Personnel assignments	■ *Describe personnel assignments and indicate those personnel (if any) not required during a well control operation.* ■ *List required information that is available prior to a well control event.* ■ *Given certain well information, define most likely well control scenarios.* ■ *Identify personnel who must coordinate effectively to effect a well kill and name their main responsibilities.*
B. Pre-recorded information	
C. Plan responses to anticipated well control scenarios	
D. Communications responsibilities	

XIII. TESTING

TRAINING TOPICS	*JOB SKILLS*
A. Testing of completion pressure control equipment 1. Packers 2. Lubricators 3. Xmas trees 4. Test trees	■ *Demonstrate the ability to line up piping and valving to perform test.*
B. Pressure and function tests 1. Maximum safe working pressures of well control equipment 2. Reasons for de-rating 3. Areas exposed to both high and low pressures during shut-in and pumping operations	■ *Identify the maximum safe working pressure for a give set of well control equipment.* ■ *List two reasons for de-rating the maximum safe working pressure of well control equipment.*
C. Installation of rings, flanges and connections	■ *Describe proper installation of rings, flanges and connections.*

XIV. GOVERNMENT, INDUSTRY AND COMPANY RULES, ORDERS AND POLICIES

TRAINING TOPICS	*JOB SKILLS*
A. Incorporate by reference 1. API and ISO recommended practices, standards and bulletins pertaining to well control 2. Regional and/or local regulations where required	■ *Describe or identify appropriate regional government regulations pertaining to job being completed.*

XV. OPTIONAL TOPICS

TRAINING TOPICS	*JOB SKILLS*
A. H2S considerations	
B. Subsea considerations	
C. Coiled tubing operations	
D. Snubbing and HWO operations	
E. Small tubing unit	
F. Wireline	
G. Operations with specific well control concerns	
1. Perforating	
2. Acidizing	
3. Stimulation (fracturing, energized fluids, etc.)	
4. Gravel packing	