

ESIM-FCC11 Drilling Simulation Training System

Technical Specification

I. System Components

1. Major Hardware

The system mainly contains driller console, top drive console, BOP console, choke console and manifold system. The devices are similar to the real equipment on drilling site.



Figure 1 System layout

a) Driller console

Driller console has three models as below. The controls and display are the same as real driller console. It can simulate draw-works raising and lowering, mud pump speed regulating, etc. and display parameters at real time, such as WOB, top drive rotary rate, standpipe pressure, casing pressure, torque, inflow rate, outflow percentage, well depth, bit position, top drive height, footage, drilling time, drilling time, drill pipe speed, bottom hole pressure, formation pressure, etc.

	<p>1) Made of metal (The console is made of steel, and the panel is made of aluminum). The size is 2000mm*1520mm*900mm.</p> <p>2) Simulating ZJ70DB AC variable frequency electrical drill rig, with</p>
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	<p>disc brake system.</p> <p>3) Integrated with a 19-inch touch screen, displaying drilling parameters.</p>
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b) Top drive console

Top drive console is designed according to the top drive model as DQ70BSC manufactured by Beijing Petroleum Machinery Factory. It can simulate various operations linkages and logics of top drive, including IBOP, turret lock, links rotation, links tilting, back up tong, operations (drill, spin, torque), direction (reverse, stop, forward), etc.

	<p>Made of metal (The console is made of steel, and the panel is made of aluminum).</p> <p>The size is 660mm*250mm*900mm.</p>
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c) BOP console

BOP console is designed according to the structure that at least as “annular-pipe ram-blind ram- pipe ram”. On the console there are indicating light for each ram (Red for close, and green for green), annular pressure regulator, air supply switch, pressure gauges. The gauges are at least air supply pressure gauge, accumulator pressure gauge, manifold pressure gauge, annular pressure gauge, etc. The BOP console simulates the line-up and close of hydraulic valves in kill manifold and choke manifold, and can also be linked with remote console.



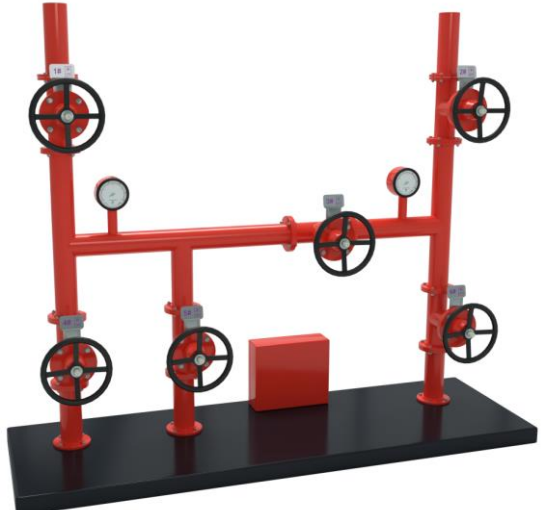


d) Choke console

Choke console simulates dual hydraulic pressure control structure. There are pump strokes reset button and choke speed adjusting regulator, and there can at least display choke position, total strokes, casing pressure, drill pipe pressure, etc.



e) Manifold system

Manifold system contains standpipe manifold, choke manifold and kill manifold. All manifolds are designed according to real manifold structure and layout. The operations are the same as real equipment.

	<p>1) Designed according to high pressure dual-path structure, with welding fixture. All hand wheels are detected by sensors, which can display pump pressure at real time according to operation requirement.</p> <p>2) Made of metal. The size is 1650mm*650mm*1650mm.</p>
	<p>1) The pipe and valves of choke manifold are made of metal, with welding fixture. All hand wheels are detected by sensors, which can control the opening and closing of the valves, and display casing pressure at real time.</p> <p>2) Made of metal. The size is 1800mm*650mm*1750mm.</p>
	<p>1) Horizontal structure. All valves are operable. And it can display kill manifold pressure according to operation requirement.</p> <p>2) Made of metal. The size is 1880mm*900mm*700mm.</p>

f) Display system

Display system adopts LED screen display.

**Large size LED true color display system**

- ◆ The 3D animation is displayed on LED true color display screen after process by professional graphics processor.
- ◆ LED P2.5 screen, resolution: 1920*1080
- ◆ Installation size: 5400mm(width)*3215mm(height)
(The ultimate installation size and resolution will be depended on installation environment)

2. System Software

(1) Master Control Software

a) Student station software module

Display drilling parameters at real time, able to set parameter alarm, and simulate the operation and display of surface circulation system.

b) Instructor station software module

The instructor can set and modify various parameters, such as formation parameter, well structure, drilling string assembly, pump parameters, mud system, surface manifold, BOP, etc. And the instructor can group, allocate the snapshot, and set the exam mode. Besides, the instructor can monitor the drilling parameters of the students from different groups such as WOB, ROP, footage, pit gain/loss, return flow, pump speed, flow rate, total strokes, etc. Problem can be set at real time during the student's operation and the parameter unit, and language can be chosen. In addition, the exercise can be saved as a new snapshot at any time.

c) Tripping in and out software module

Provides normal tripping in and out training

d) Drilling software module

Provides normal drilling training

e) Problems and troubles software module

Simulates various problems in the process of drilling and tripping in and out.

f) Well control software module

Able to realize well control operation, showing well control parameters such as casing pressure, drill pipe pressure, choke position, casing shoe pressure, BHP, etc. at real time. Can save and print various parameter curves such as drill pipe pressure, casing pressure, pit gain/loss, BHP, formation pressure, etc.

g) Sound effect control module software

Able to simulate the noises of pumps, drawworks, rotary table, etc. on drilling site.

h) System self-checking module

Able to diagnose the hardware state through this module.

i) Students' management module

(2) Graphics Software

a) Top drive-based 3D display software module

b) Rotary table drive kelly based 3D display software module

II. System Functions

(1) Sound effect simulation

The simulated noises of the simulator are the same as that on real site, such when the drilling equipment is running, collision, speed up and down.

(2) Simulator function

The simulator provides training for different posts such as driller, driller assistant, drilling crew technician, drilling crew leader, drilling supervisor, etc. The simulation training can enable trainee to master the skills of soft/ hard shut-in, and conventional/unconventional well killing.

The simulator adopts mathematical models to simulate various working condition and parameters in petroleum engineering drilling operation, such as pressure, torque, ROP, flow rate, etc. and can reflect the relations between these parameters, which realizes the same effect as in real drilling operation.

The simulator enables user to set various drilling parameters, such as drilling string assembly, well structure, formation parameters, device parameters, etc. which makes the training more flexible and targeted. The software program adopts non-sequence structure, which can simulate various rig operation, and closer to reality. Virtual reality technology makes up a vivid perceptual environment, and 3D animation is synchronic with the real operation.

The simulator is made according to industrial standard, Data acquisition and control system is completed by PLC, which ensures the reliability of the system.

(3) System features

1) The system complies with the training standard of IWCF and IADC.

2) The system has non-sequence structure, which has no operation sequence limit to trainees. It simulates the model and functions of real drill rig. Operator can operate the system in any way just as operating real drill rig.

3) The system has the function of provide various operations by uploading one well condition snapshot. With one appropriate well condition snapshot, student can be trained of series of operations of tripping in and out, drilling, overflow, shutting in and well killing.

4) Parameters can be set freely. Instructor can set various parameters, such as drilling string make up, formation parameters, mud parameters, devices parameters, etc. Instructor can also

customize the parameters based on actual well condition and devices, so that the training is just like operating on a real well.

5) The system provides problem setting function. Instructor can set various device fault or down-hole problem during student operating. And students can judge the problems by observing the change of parameters. Instructor can set problems or faults such as pipe leakage, nozzle plug, choke valve seizing, pump fault, BOP fault, etc.

6) The system provides speed control function. Instructor can increase and reduce the speed of the exercise when necessary.

7) The system also has alarm setting function. Trainees can set various parameter limits. When parameters exceed these limits, the system will launch an alarm. The launching and stopping of alarm comply with student's operation, working condition and graphics.

8) 3D animation simulates site visual environment. Animation can present down-hole scene, devices motion and device working theories. The animation can also display the relationship, standing position and operation rules of different working post in drilling. The scene can be displayed on the screen by shifting scenes and in split screen way, such as ranking platform, drilling fluid flow line, various curves and real time data, etc.

9) The system has lifelike scene sound effect. The system can simulate various sounds in real site. The launching and stopping of sounds comply with student's operation, working condition and graphics.

10) The system can display the changing trend of important parameters in the form of curves, so that students can judge down-hole condition and problem through the curves.

11) It has curves playback function, which can replay the parameter changes during students' operation in the form of curves for students review.

12) The system has training control function. It can freeze, save and resume exercise at any time.

13) The measurement unit can be in Metric and also English.

14) The system provides Chinese and English interfaces that can be shifted at real-time.

15) The system has automatic scoring function. It can give out score to student's operation, and also the point deduction reasons.

16) It has completed student management function.

17) The system has one-key to start function.

III. Training Items

1. Preparation
 - 1) Formation fracturing pressure test
2. Conventional operation
 - 1) Normal drilling
 - 2) Normal tripping in
 - 3) Normal tripping out
3. Shut-in operation
 - 1) Shutting in operation when kick occurs during drilling
 - 2) Shutting in operation when kick occurs during tripping out drill pipe
 - 3) Stripping in after shut-in while tripping out
 - 4) Shutting in operation when kick occurs during tripping out drill collar
 - 5) Shut-in when kick occurs while out of the hole
4. Well control operation
 - 1) Driller's method
 - 2) Engineer's method
 - 3) Volumetric method
 - 4) Bull heading
5. Judging and handling of down hole problems
 - 1) Getting blocked when tripping in
 - 2) Getting stuck when tripping out
 - 3) Sand settling
 - 4) Adhesion sticking
 - 5) Key seat sticking
 - 6) Balling up
 - 7) Hole caving sticking
 - 8) Hole shrinkage sticking
 - 9) Fishing tap
 - 10) Junk milling
 - 11) Drilling with bouncing bit
 - 12) Drilling in leakage zone

IV. Simulation technology features

- (1) During drilling, the system can simulate calculating WOB. After pump is started, the system can calculate pump pressure. During tripping, the system can calculate the fluctuating pressure.
- (2) The system can simulate hard shut-in process and soft shut-in process.
- (3) The system can simulate shut-in with blow-out preventer inside drill string (such as cock, back pressure valve.)
- (4) After shut-in, the system can calculate shut-in drill pipe pressure of the drill string with non-return valve.
- (5) The system can simulate the pressure change of gas migration.
- (6) The system can calculate the friction when drill pipe or pipe coupling passing through the closed annular and pipe ram.
- (7) The system can reflect the fluctuating pressure when pipe coupling passing through the closed annular ram.
- (8) During exercise, problems can be inserted at any time.

V. Technical Parameters and Operation Condition

(1) Power Parameters

- 1) Operation voltage: 110~220V/ 50~60 Hz AC
- 2) Device power consumption: 2.5 KW
- 3) LED power consumption: 15KW

(2) Installation Condition

- 1) Area: $\geq 40\text{m}^2$
- 2) Working temperature: 0~30 °C
- 3) Relative humidity: <90%

VI. Program Interface

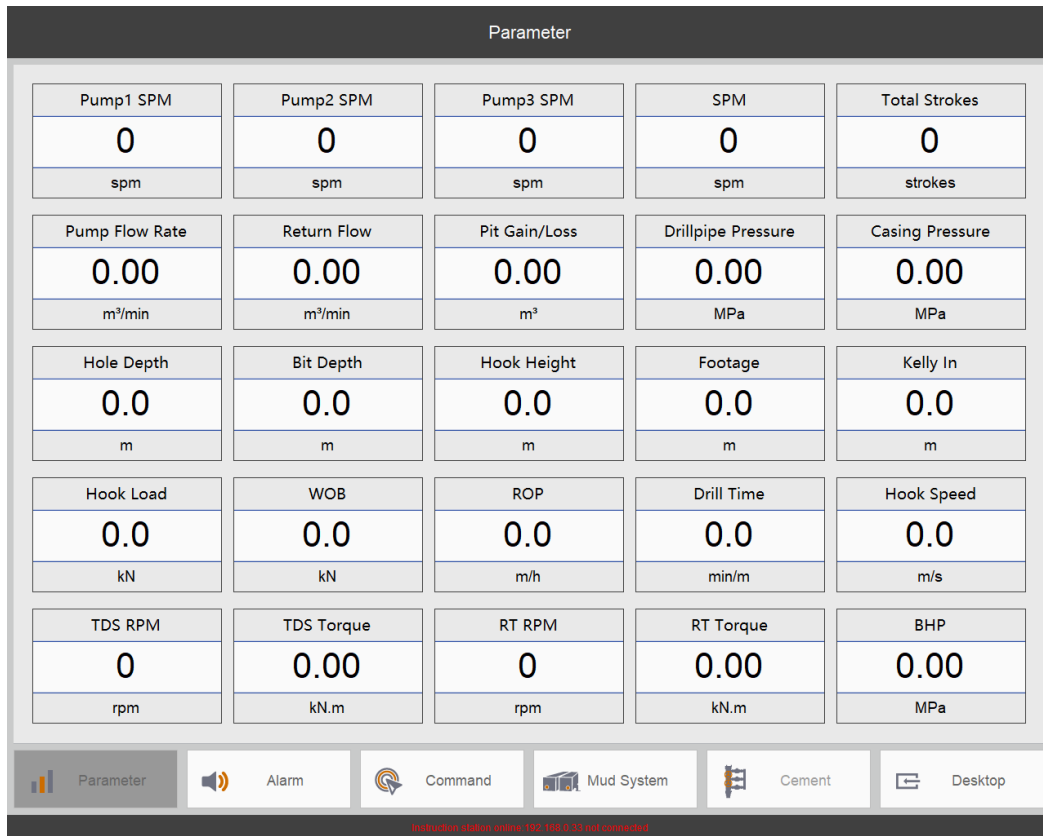


Figure 2 Student screen

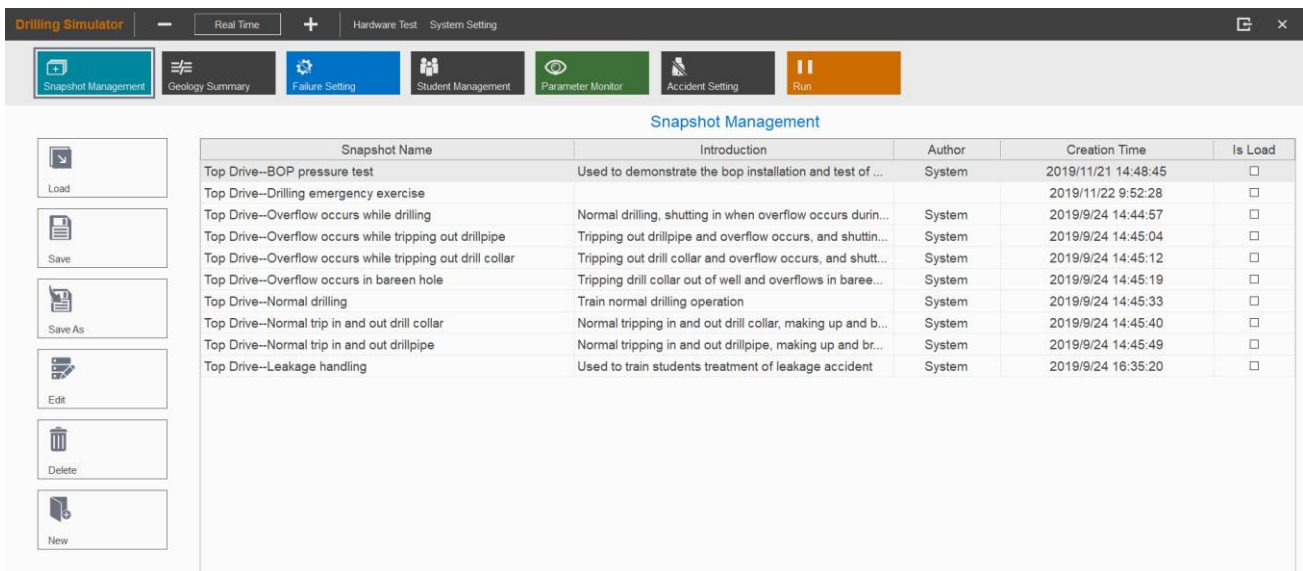


Figure 3 Instructor screen

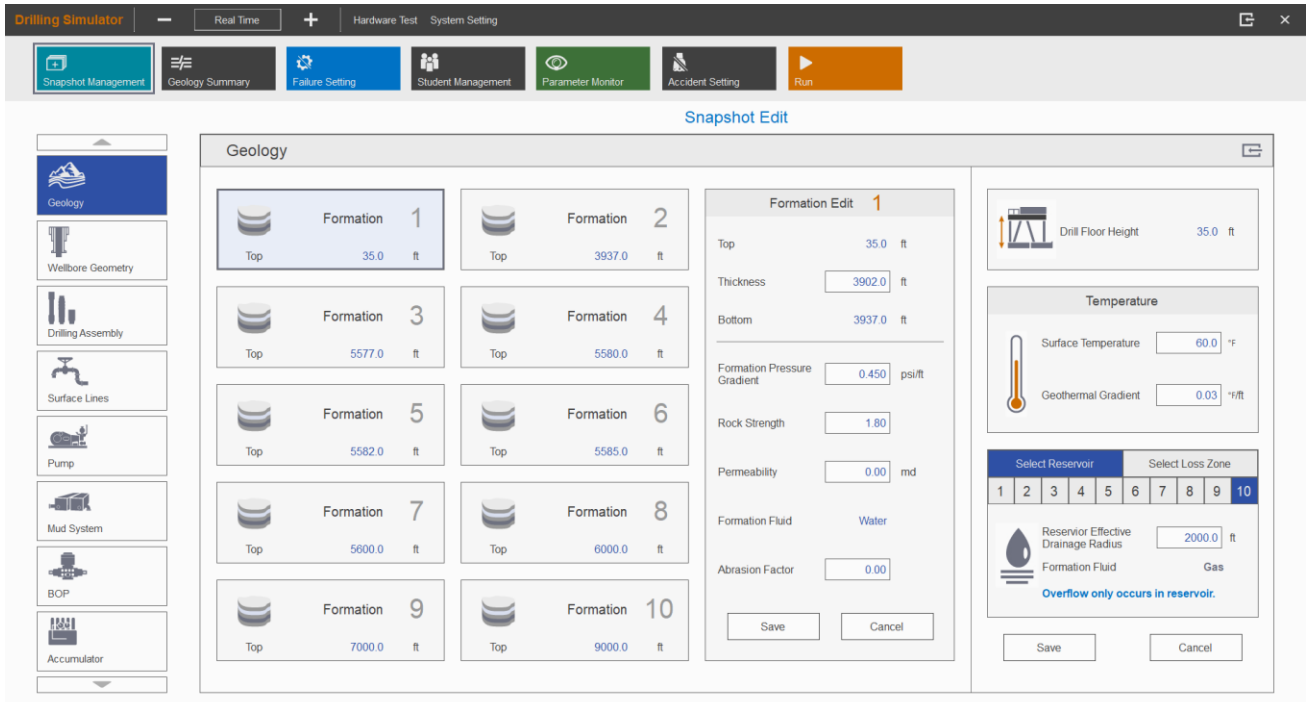


Figure 4 Parameter setting screen



Figure 5 Graphics screen--- Kelly



Figure 6 Graphics screen--- Top drive