

HALLIBURTON

Sperry Drilling

6360 East Yellowstone Hwy, Evansville, WY 82636

Tel: 307-472-5757 Fax: 307-232-2097

Certified Survey Sheet

Company: True Oil LLC

Project: Arapahoe County, CO

Site (S-T-R): Sec. 15-T5S-R64W (HNR Re-Stake)

Well Name: Thunder 5-64 15-16-1CHZ

Wellbore: OWB

Survey: Final Surveys

API: 05-005-07340

Depth Reference (Rig): KB 27' @ 5961.00usft (True 33)

Ground Elev: 5934.00

Annotations

Tie-On to Last Surface Survey @ 2097.00' MD

First Sperry MWD Survey @ 2238.00' MD

Last Sperry MWD Survey @ 17923.00' MD

Straight Line Projection to TD @ 17991.00' MD

I certify that the attached survey is true and correct to the best of my knowledge.



Jerry Popp
Well Design Engineer

HALLIBURTON SPERRY DRILLING SERVICES

CERTIFIED SURVEY WORK SHEET

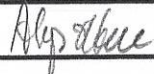
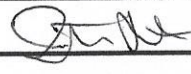
OPERATOR:	True Oil LLC
WELL:	Thunder 5-64 15-16-1CHZ
FIELD:	Wildcat
RIG:	True 33
LEGALS:	Sec.15-T5S -R64W
COUNTY:	Arapahoe
STATE:	Colorado
CAL. METHOD:	Grid
MAG. DECL. APPLIED:	8.09
VERTICAL SEC. DIR. :	266.580

SSDS Job Number :	904882718
Start Date of Job :	6/21/2018
End Date of Job :	6/30/2018
Lead Directional Driller:	Alex Akpokiere
	Thamer Bahassan
Other SDS DD's :	
SDS MWD Engineers :	Jonathan Parrish
	Matt Harrington

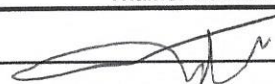
	Main Hole =====>		1st Side Track =====>		2nd Side Track =====>		3rd Side Track =====>		4th Side Track =====>	
	0.00	Tie On		Tie On		Tie On		Tie On		Tie On
First Survey Depth	27.00									
Last Survey Depth	2097.00									
KOP Depth/Sidetrack MD	7157.00	KOP		KOP-ST1		KOP-ST2		KOP-ST3		KOP-ST4
First Survey Depth	2238.00	MWD		MWD		MWD		MWD		MWD
Last Survey Depth	17923.00	MWD		MWD		MWD		MWD		MWD
Bit Extrapolation to TD	17991.00	T.D.		T.D.		T.D.		T.D.		T.D.

The following Halliburton Sperry Drilling Services personnel listed below, do certify the above survey information to be accurate :

Print Name : Alex Akpokiere Print Name : Jonathan Parrish Print Name : _____

Sign Name :  Sign Name :  Sign Name : _____

Print Name : Thamer Bahassan Print Name : Matt Harrington Print Name : _____

Sign Name :  Sign Name : _____ Sign Name : _____

Examples of Survey Types:

TieOn Tie On to Surface Casing (Assumed Vertical), Tie On to existing MWD Survey (prior drilled hole)
MWD Sperry Drilling Services (SDS) Measurement While Drilling (MWD) Survey's
ESS Sperry Drilling Services (SDS) Electronic Survey System (ESS) Survey's
Gyro Gyro Survey's ; Provided by third party vendor, or by Sperry Drilling Services (SDS)
SS Single Shot (SS) Survey's ; Provided by Sperry Drilling Services (SDS) or third party vendor.

Project: Arapahoe County, CO
Site: Sec. 15-T5S-R64W (HNR Re-Stake)
Well: Thunder 5-64 15-16-1CHZ
Wellbore: OWB
Design: Final Surveys

True Oil LLC True 33

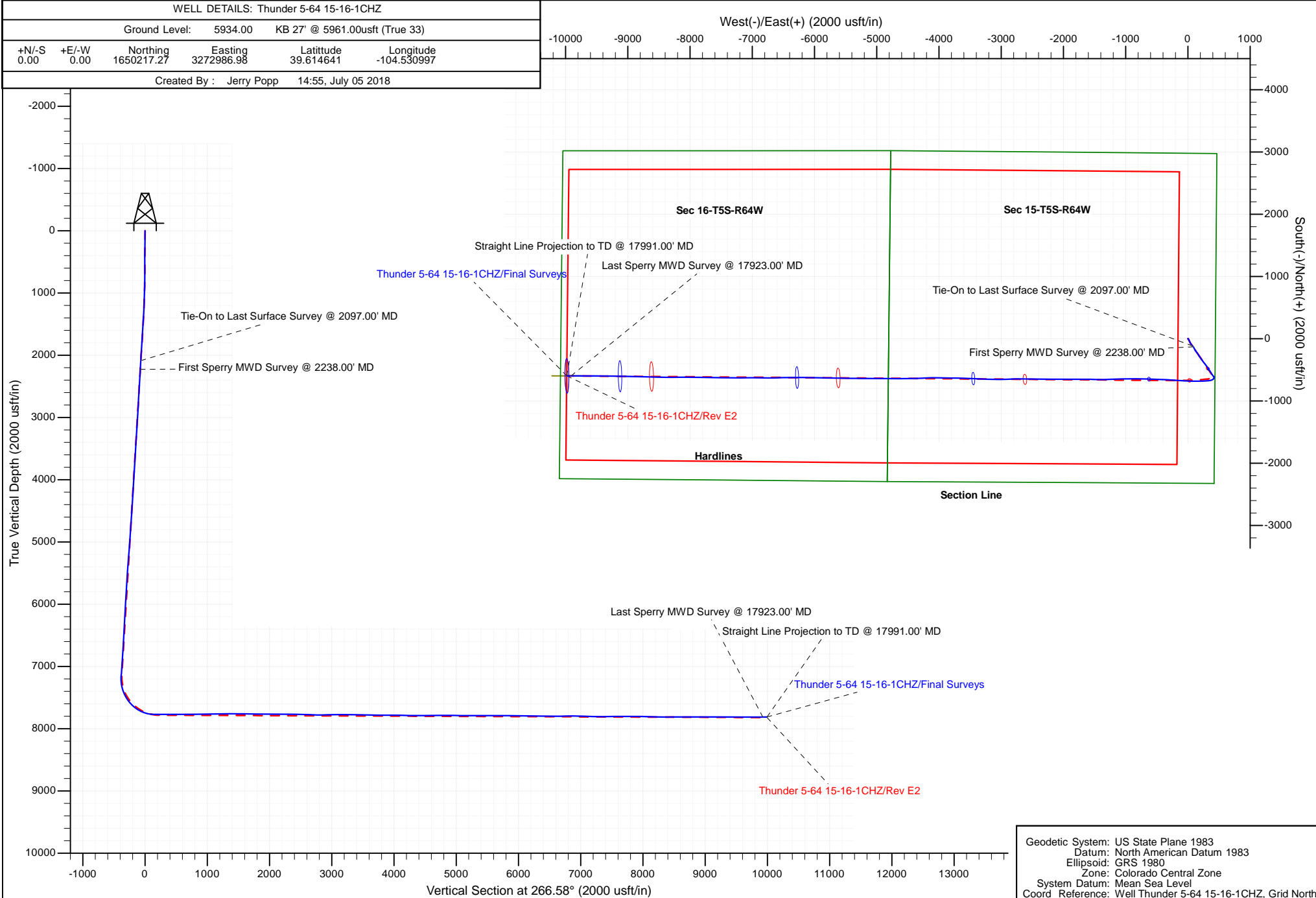


WELL DETAILS: Thunder 5-64 15-16-1CHZ

Ground Level: 5934.00 KB 27' @ 5961.00usft (True 33)

+N/-S	+E/-W	Northing	Easting	Latitude	Longitude
0.00	0.00	1650217.27	3272986.98	39.614641	-104.530997

Created By : Jerry Popp 14:55, July 05 2018



Geodetic System: US State Plane 1983
Datum: North American Datum 1983
Ellipsoid: GRS 1980
Zone: Colorado Central Zone
System Datum: Mean Sea Level
Coord Reference: Well Thunder 5-64 15-16-1CHZ, Grid North

Design Report for Thunder 5-64 15-16-1CHZ - Final Surveys

Measured Depth (usft)	Inclination (°)	Grid Azimuth (°)	TVD below System (usft)	Vertical Depth (usft)	Local Coordinates (usft)		Map Coordinates (usft)		Dogleg Rate (°/100usft)	Vertical Section (usft)	Comments
					Northing	Easting	Northing	Easting			
0.00	0.00	0.00	-5,961.00	0.00	0.00 N	0.00 E	1,650,217.27	3,272,986.98	0.00	0.00	
27.00	0.00	0.00	-5,934.00	27.00	0.00 N	0.00 E	1,650,217.27	3,272,986.98	0.00	0.00	Ground Level Assumed Vertical @ 27.00' MD
328.00	0.49	77.62	-5,633.00	328.00	0.28 N	1.26 E	1,650,217.55	3,272,988.24	0.16	-1.27	First BH MWD Survey @ 328.00' MD
421.00	0.65	89.38	-5,540.01	420.99	0.37 N	2.17 E	1,650,217.64	3,272,989.16	0.21	-2.19	
514.00	0.35	4.89	-5,447.01	513.99	0.66 N	2.72 E	1,650,217.93	3,272,989.71	0.76	-2.76	
607.00	0.50	39.88	-5,354.01	606.99	1.25 N	3.01 E	1,650,218.52	3,272,989.99	0.31	-3.08	
701.00	0.47	17.37	-5,260.02	700.98	1.93 N	3.39 E	1,650,219.20	3,272,990.37	0.20	-3.50	
794.00	0.93	106.08	-5,167.02	793.98	2.09 N	4.23 E	1,650,219.36	3,272,991.21	1.11	-4.34	
887.00	1.90	142.91	-5,074.05	886.95	0.65 N	5.88 E	1,650,217.92	3,272,992.86	1.38	-5.91	
980.00	3.30	142.60	-4,981.15	979.85	2.71 S	8.44 E	1,650,214.56	3,272,995.42	1.51	-8.26	
1,074.00	4.81	161.46	-4,887.38	1,073.62	8.59 S	11.33 E	1,650,208.68	3,272,998.32	2.12	-10.80	
1,167.00	6.20	161.13	-4,794.81	1,166.19	17.04 S	14.20 E	1,650,200.23	3,273,001.18	1.50	-13.16	
1,260.00	7.32	153.10	-4,702.46	1,258.54	27.08 S	18.50 E	1,650,190.19	3,273,005.49	1.57	-16.86	
1,354.00	7.55	152.00	-4,609.25	1,351.75	37.87 S	24.11 E	1,650,179.40	3,273,011.09	0.29	-21.81	
1,449.00	7.45	152.99	-4,515.06	1,445.94	48.87 S	29.84 E	1,650,168.40	3,273,016.82	0.17	-26.87	
1,543.00	7.26	152.87	-4,421.84	1,539.16	59.59 S	35.31 E	1,650,157.69	3,273,022.30	0.20	-31.70	
1,638.00	7.48	147.58	-4,327.62	1,633.38	70.15 S	41.37 E	1,650,147.13	3,273,028.35	0.75	-37.11	
1,733.00	6.89	147.13	-4,233.37	1,727.63	80.15 S	47.77 E	1,650,137.12	3,273,034.76	0.62	-42.91	
1,828.00	6.88	141.81	-4,139.05	1,821.95	89.41 S	54.39 E	1,650,127.86	3,273,041.37	0.67	-48.96	
1,923.00	7.26	143.81	-4,044.77	1,916.23	98.73 S	61.45 E	1,650,118.54	3,273,048.43	0.48	-55.45	
2,017.00	7.11	141.45	-3,951.51	2,009.49	108.07 S	68.58 E	1,650,109.20	3,273,055.56	0.35	-62.02	
2,097.00	6.67	143.96	-3,872.09	2,088.91	115.70 S	74.40 E	1,650,101.57	3,273,061.38	0.67	-67.37	Last BH MWD Survey @ 2097.00' MD - Tie-On to Last Surface Survey @ 2097.00' MD
2,238.00	6.77	141.07	-3,732.06	2,228.94	128.79 S	84.44 E	1,650,088.49	3,273,071.42	0.25	-76.61	First Sperry MWD Survey @ 2238.00' MD
2,331.00	6.71	140.68	-3,639.70	2,321.30	137.25 S	91.33 E	1,650,080.02	3,273,078.31	0.08	-82.98	
2,426.00	6.59	151.91	-3,545.33	2,415.67	146.36 S	97.41 E	1,650,070.92	3,273,084.39	1.37	-88.51	
2,521.00	6.67	153.75	-3,450.97	2,510.03	156.12 S	102.42 E	1,650,061.16	3,273,089.40	0.24	-92.93	
2,615.00	6.67	154.85	-3,357.61	2,603.39	165.95 S	107.15 E	1,650,051.32	3,273,094.13	0.14	-97.07	
2,710.00	6.88	145.43	-3,263.27	2,697.73	175.63 S	112.73 E	1,650,041.64	3,273,099.71	1.19	-102.06	
2,805.00	6.92	145.42	-3,168.95	2,792.05	185.03 S	119.20 E	1,650,032.25	3,273,106.18	0.04	-107.96	
2,900.00	6.85	146.24	-3,074.64	2,886.36	194.45 S	125.60 E	1,650,022.82	3,273,112.58	0.13	-113.78	
2,995.00	6.80	146.76	-2,980.31	2,980.69	203.87 S	131.83 E	1,650,013.41	3,273,118.81	0.08	-119.44	
3,090.00	6.63	145.88	-2,885.96	3,075.04	213.11 S	137.99 E	1,650,004.17	3,273,124.97	0.21	-125.04	
3,185.00	6.55	145.73	-2,791.59	3,169.41	222.13 S	144.12 E	1,649,995.15	3,273,131.10	0.09	-130.62	
3,279.00	6.16	144.54	-2,698.17	3,262.83	230.67 S	150.06 E	1,649,986.61	3,273,137.04	0.44	-136.04	
3,374.00	6.96	146.98	-2,603.79	3,357.21	239.64 S	156.15 E	1,649,977.63	3,273,143.13	0.89	-141.59	
3,469.00	6.70	147.89	-2,509.47	3,451.53	249.16 S	162.24 E	1,649,968.11	3,273,149.22	0.30	-147.10	
3,564.00	6.42	148.18	-2,415.09	3,545.91	258.37 S	167.98 E	1,649,958.91	3,273,154.96	0.30	-152.28	
3,659.00	7.06	145.36	-2,320.74	3,640.26	267.69 S	174.10 E	1,649,949.59	3,273,161.08	0.76	-157.84	
3,754.00	6.94	145.10	-2,226.45	3,734.55	277.20 S	180.70 E	1,649,940.08	3,273,167.68	0.13	-163.86	
3,848.00	6.44	146.46	-2,133.09	3,827.91	286.25 S	186.87 E	1,649,931.03	3,273,173.85	0.56	-169.47	

Design Report for Thunder 5-64 15-16-1CHZ - Final Surveys

Measured Depth (usft)	Inclination (°)	Grid Azimuth (°)	TVD below System (usft)	Vertical Depth (usft)	Local Coordinates		Map Coordinates		Dogleg Rate (°/100usft)	Vertical Section (usft)	Comments
					Northing (usft)	Easting (usft)	Northing (usft)	Easting (usft)			
3,943.00	7.22	144.12	-2,038.77	3,922.23	295.53 S	193.31 E	1,649,921.75	3,273,180.29	0.87	-175.35	
4,038.00	6.72	144.26	-1,944.47	4,016.53	304.88 S	200.05 E	1,649,912.40	3,273,187.03	0.53	-181.52	
4,133.00	5.96	144.82	-1,850.05	4,110.95	313.42 S	206.14 E	1,649,903.86	3,273,193.12	0.80	-187.09	
4,227.00	7.64	145.55	-1,756.72	4,204.28	322.56 S	212.49 E	1,649,894.72	3,273,199.47	1.79	-192.88	
4,322.00	6.98	143.49	-1,662.49	4,298.51	332.41 S	219.50 E	1,649,884.87	3,273,206.48	0.75	-199.29	
4,417.00	6.58	144.23	-1,568.15	4,392.85	341.46 S	226.11 E	1,649,875.81	3,273,213.09	0.43	-205.36	
4,512.00	6.09	145.48	-1,473.73	4,487.27	350.03 S	232.15 E	1,649,867.25	3,273,219.13	0.54	-210.87	
4,606.00	7.43	143.98	-1,380.39	4,580.61	359.06 S	238.55 E	1,649,858.22	3,273,225.53	1.44	-216.72	
4,701.00	6.91	141.66	-1,286.13	4,674.87	368.51 S	245.71 E	1,649,848.77	3,273,232.69	0.63	-223.30	
4,796.00	6.07	140.11	-1,191.74	4,769.26	376.84 S	252.47 E	1,649,840.44	3,273,239.45	0.90	-229.56	
4,891.00	7.20	146.37	-1,097.38	4,863.62	385.66 S	258.99 E	1,649,831.62	3,273,245.97	1.41	-235.54	
4,985.00	6.89	142.44	-1,004.09	4,956.91	395.03 S	265.69 E	1,649,822.25	3,273,252.67	0.61	-241.67	
5,080.00	6.46	136.45	-909.73	5,051.27	403.42 S	272.85 E	1,649,813.86	3,273,259.82	0.86	-248.31	
5,175.00	8.06	141.44	-815.49	5,145.51	412.50 S	280.68 E	1,649,804.78	3,273,267.66	1.81	-255.59	
5,269.00	8.63	143.68	-722.49	5,238.51	423.34 S	288.97 E	1,649,793.94	3,273,275.94	0.70	-263.22	
5,364.00	8.44	141.82	-628.54	5,332.46	434.56 S	297.50 E	1,649,782.72	3,273,284.47	0.35	-271.06	
5,459.00	8.29	148.75	-534.55	5,426.45	445.90 S	305.36 E	1,649,771.38	3,273,292.34	1.07	-278.24	
5,554.00	8.15	149.11	-440.53	5,520.47	457.53 S	312.37 E	1,649,759.75	3,273,299.35	0.16	-284.54	
5,649.00	7.41	147.45	-346.40	5,614.60	468.47 S	319.12 E	1,649,748.81	3,273,306.10	0.81	-290.63	
5,743.00	6.04	147.72	-253.05	5,707.95	477.76 S	325.03 E	1,649,739.52	3,273,312.00	1.46	-295.97	
5,838.00	6.12	152.42	-158.58	5,802.42	486.48 S	330.04 E	1,649,730.80	3,273,317.02	0.53	-300.45	
5,933.00	6.72	144.52	-64.18	5,896.82	495.49 S	335.61 E	1,649,721.79	3,273,322.59	1.12	-305.48	
6,027.00	5.43	138.50	29.29	5,990.29	503.30 S	341.75 E	1,649,713.98	3,273,328.73	1.53	-311.14	
6,122.00	6.44	147.04	123.78	6,084.78	511.14 S	347.63 E	1,649,706.14	3,273,334.60	1.41	-316.54	
6,217.00	6.29	137.83	218.20	6,179.20	519.47 S	354.02 E	1,649,697.82	3,273,341.00	1.09	-322.43	
6,312.00	7.48	148.56	312.52	6,273.52	528.60 S	360.74 E	1,649,688.68	3,273,347.72	1.84	-328.59	
6,407.00	7.26	150.46	406.73	6,367.73	539.10 S	366.92 E	1,649,678.18	3,273,353.90	0.35	-334.14	
6,501.00	6.26	145.02	500.08	6,461.08	548.47 S	372.79 E	1,649,668.82	3,273,359.77	1.26	-339.43	
6,596.00	5.56	152.64	594.58	6,555.58	556.80 S	377.88 E	1,649,660.49	3,273,364.85	1.11	-344.01	
6,691.00	6.45	150.29	689.05	6,650.05	565.52 S	382.64 E	1,649,651.76	3,273,369.61	0.97	-348.24	
6,786.00	7.54	146.04	783.35	6,744.35	575.32 S	388.76 E	1,649,641.96	3,273,375.74	1.27	-353.78	
6,881.00	6.59	143.19	877.62	6,838.62	584.86 S	395.51 E	1,649,632.43	3,273,382.48	1.07	-359.94	
6,975.00	6.74	138.81	970.99	6,931.99	593.33 S	402.38 E	1,649,623.96	3,273,389.35	0.56	-366.29	
7,070.00	6.11	139.09	1,065.39	7,026.39	601.34 S	409.36 E	1,649,615.94	3,273,396.33	0.66	-372.78	
7,165.00	5.55	122.19	1,159.91	7,120.91	607.61 S	416.56 E	1,649,609.67	3,273,403.53	1.89	-379.60	
7,260.00	11.84	173.13	1,253.88	7,214.88	619.76 S	421.62 E	1,649,597.52	3,273,408.60	9.87	-383.93	
7,355.00	17.64	212.81	1,345.94	7,306.94	641.61 S	414.97 E	1,649,575.68	3,273,401.94	11.91	-375.98	
7,450.00	21.77	245.55	1,435.62	7,396.62	661.07 S	391.05 E	1,649,556.22	3,273,378.02	12.22	-350.95	
7,544.00	26.26	264.59	1,521.60	7,482.60	670.26 S	354.40 E	1,649,547.03	3,273,341.38	9.47	-313.82	
7,639.00	38.71	265.13	1,601.57	7,562.57	674.78 S	303.68 E	1,649,542.51	3,273,290.66	13.11	-262.92	
7,734.00	48.41	266.97	1,670.34	7,631.34	679.19 S	238.45 E	1,649,538.10	3,273,225.43	10.30	-197.54	

Design Report for Thunder 5-64 15-16-1CHZ - Final Surveys

Measured		Grid	TVD below	Vertical	Local Coordinates		Map Coordinates		Dogleg	Vertical	
Depth	Inclination	Azimuth	System	Depth	Northing	Easting	Northing	Easting	Rate	Section	Comments
(usft)	(°)	(°)	(usft)	(usft)	(usft)	(usft)	(usft)	(usft)	(°/100usft)	(usft)	
7,829.00	56.53	270.00	1,728.17	7,689.17	681.07 S	163.21 E	1,649,536.22	3,273,150.19	8.91	-122.32	
7,924.00	66.92	270.97	1,773.11	7,734.11	680.33 S	79.67 E	1,649,536.96	3,273,066.65	10.97	-38.97	
8,019.00	78.62	272.41	1,801.20	7,762.20	677.62 S	10.87 W	1,649,539.66	3,272,976.12	12.40	51.24	
8,114.00	90.65	274.39	1,810.07	7,771.07	672.01 S	105.11 W	1,649,545.28	3,272,881.88	12.83	144.98	
8,209.00	89.75	273.63	1,809.74	7,770.74	665.36 S	199.87 W	1,649,551.92	3,272,787.12	1.24	239.18	
8,256.00	90.15	273.58	1,809.78	7,770.78	662.41 S	246.78 W	1,649,554.88	3,272,740.21	0.86	285.83	
8,350.00	89.69	272.79	1,809.91	7,770.91	657.19 S	340.63 W	1,649,560.10	3,272,646.36	0.97	379.20	
8,445.00	89.51	271.70	1,810.57	7,771.57	653.47 S	435.56 W	1,649,563.82	3,272,551.44	1.16	473.73	
8,540.00	90.34	271.24	1,810.70	7,771.70	651.03 S	530.52 W	1,649,566.26	3,272,456.47	1.00	568.39	
8,635.00	91.23	271.41	1,809.39	7,770.39	648.83 S	625.49 W	1,649,568.45	3,272,361.51	0.95	663.05	
8,730.00	90.00	271.38	1,808.38	7,769.38	646.52 S	720.45 W	1,649,570.77	3,272,266.55	1.30	757.71	
8,825.00	89.75	272.05	1,808.58	7,769.58	643.68 S	815.41 W	1,649,573.61	3,272,171.59	0.75	852.33	
8,920.00	90.28	270.48	1,808.56	7,769.56	641.58 S	910.38 W	1,649,575.71	3,272,076.62	1.74	947.01	
9,014.00	90.92	268.02	1,807.57	7,768.57	642.81 S	1,004.36 W	1,649,574.48	3,271,982.65	2.70	1,040.89	
9,109.00	91.54	267.14	1,805.53	7,766.53	646.82 S	1,099.25 W	1,649,570.47	3,271,887.76	1.13	1,135.86	
9,204.00	91.63	268.15	1,802.91	7,763.91	650.72 S	1,194.14 W	1,649,566.57	3,271,792.88	1.07	1,230.80	
9,299.00	91.69	268.41	1,800.15	7,761.15	653.57 S	1,289.05 W	1,649,563.71	3,271,697.96	0.28	1,325.72	
9,393.00	89.57	269.86	1,799.12	7,760.12	654.99 S	1,383.03 W	1,649,562.30	3,271,603.99	2.73	1,419.61	
9,488.00	89.48	272.12	1,799.91	7,760.91	653.35 S	1,478.01 W	1,649,563.94	3,271,509.01	2.38	1,514.32	
9,583.00	88.55	270.26	1,801.54	7,762.54	651.38 S	1,572.97 W	1,649,565.91	3,271,414.06	2.19	1,609.00	
9,678.00	88.58	269.95	1,803.92	7,764.92	651.20 S	1,667.94 W	1,649,566.08	3,271,319.09	0.33	1,703.79	
9,772.00	88.95	270.19	1,805.95	7,766.95	651.09 S	1,761.91 W	1,649,566.20	3,271,225.11	0.47	1,797.59	
9,867.00	89.57	270.28	1,807.17	7,768.17	650.70 S	1,856.90 W	1,649,566.59	3,271,130.12	0.66	1,892.39	
9,962.00	90.12	270.50	1,807.43	7,768.43	650.05 S	1,951.90 W	1,649,567.24	3,271,035.13	0.62	1,987.18	
10,057.00	89.14	269.82	1,808.04	7,769.04	649.79 S	2,046.90 W	1,649,567.50	3,270,940.14	1.26	2,081.99	
10,151.00	89.75	269.84	1,808.95	7,769.95	650.06 S	2,140.89 W	1,649,567.22	3,270,846.14	0.65	2,175.84	
10,246.00	91.17	270.74	1,808.19	7,769.19	649.58 S	2,235.88 W	1,649,567.70	3,270,751.15	1.77	2,270.63	
10,339.00	88.83	270.98	1,808.19	7,769.19	648.19 S	2,328.87 W	1,649,569.10	3,270,658.17	2.53	2,363.36	
10,433.00	88.15	271.00	1,810.67	7,771.67	646.56 S	2,422.82 W	1,649,570.72	3,270,564.22	0.72	2,457.05	
10,526.00	88.52	271.15	1,813.37	7,774.37	644.82 S	2,515.76 W	1,649,572.47	3,270,471.28	0.43	2,549.73	
10,620.00	88.43	271.09	1,815.87	7,776.87	642.98 S	2,609.71 W	1,649,574.30	3,270,377.33	0.12	2,643.40	
10,713.00	88.52	269.72	1,818.35	7,779.35	642.33 S	2,702.68 W	1,649,574.96	3,270,284.37	1.48	2,736.16	
10,806.00	90.09	267.86	1,819.48	7,780.48	644.29 S	2,795.64 W	1,649,573.00	3,270,191.41	2.62	2,829.08	
10,900.00	90.80	266.82	1,818.75	7,779.75	648.65 S	2,889.53 W	1,649,568.63	3,270,097.52	1.34	2,923.06	
10,993.00	91.45	268.76	1,816.92	7,777.92	652.24 S	2,982.44 W	1,649,565.05	3,270,004.61	2.20	3,016.02	
11,086.00	91.05	270.53	1,814.89	7,775.89	652.81 S	3,075.42 W	1,649,564.47	3,269,911.64	1.95	3,108.86	
11,180.00	89.69	271.78	1,814.28	7,775.28	650.92 S	3,169.39 W	1,649,566.37	3,269,817.67	1.97	3,202.56	
11,273.00	88.86	272.16	1,815.46	7,776.46	647.72 S	3,262.33 W	1,649,569.56	3,269,724.74	0.98	3,295.14	
11,366.00	89.05	272.45	1,817.16	7,778.16	643.98 S	3,355.24 W	1,649,573.30	3,269,631.83	0.37	3,387.66	
11,460.00	89.57	273.27	1,818.29	7,779.29	639.29 S	3,449.11 W	1,649,577.99	3,269,537.96	1.03	3,481.09	
11,553.00	88.95	271.61	1,819.49	7,780.49	635.33 S	3,542.01 W	1,649,581.95	3,269,445.05	1.91	3,573.59	

Design Report for Thunder 5-64 15-16-1CHZ - Final Surveys

Measured Depth (usft)	Inclination (°)	Grid Azimuth (°)	TVD below System (usft)	Vertical Depth (usft)	Local Coordinates		Map Coordinates		Dogleg Rate (°/100usft)	Vertical Section (usft)	Comments
					Northing (usft)	Easting (usft)	Northing (usft)	Easting (usft)			
11,646.00	88.92	270.70	1,821.22	7,782.22	633.46 S	3,634.98 W	1,649,583.83	3,269,352.09	0.98	3,666.28	
11,740.00	89.05	270.49	1,822.88	7,783.88	632.48 S	3,728.96 W	1,649,584.80	3,269,258.11	0.26	3,760.03	
11,833.00	89.82	271.04	1,823.80	7,784.80	631.24 S	3,821.95 W	1,649,586.04	3,269,165.13	1.02	3,852.78	
11,926.00	90.55	271.68	1,823.50	7,784.50	629.04 S	3,914.92 W	1,649,588.25	3,269,072.16	1.04	3,945.45	
12,019.00	89.11	271.94	1,823.78	7,784.78	626.10 S	4,007.87 W	1,649,591.19	3,268,979.21	1.57	4,038.06	
12,113.00	88.31	269.09	1,825.89	7,786.89	625.25 S	4,101.83 W	1,649,592.03	3,268,885.25	3.15	4,131.81	
12,206.00	89.02	267.40	1,828.06	7,789.06	628.10 S	4,194.76 W	1,649,589.19	3,268,792.33	1.97	4,224.74	
12,301.00	89.29	267.24	1,829.46	7,790.46	632.54 S	4,289.64 W	1,649,584.74	3,268,697.44	0.33	4,319.72	
12,396.00	89.94	268.74	1,830.10	7,791.10	635.87 S	4,384.58 W	1,649,581.41	3,268,602.51	1.72	4,414.69	
12,491.00	90.49	268.79	1,829.74	7,790.74	637.92 S	4,479.56 W	1,649,579.36	3,268,507.54	0.58	4,509.62	
12,585.00	91.23	268.41	1,828.33	7,789.33	640.22 S	4,573.52 W	1,649,577.07	3,268,413.58	0.88	4,603.55	
12,680.00	89.91	270.16	1,827.39	7,788.39	641.40 S	4,668.50 W	1,649,575.88	3,268,318.60	2.31	4,698.43	
12,775.00	89.85	270.85	1,827.59	7,788.59	640.57 S	4,763.49 W	1,649,576.72	3,268,223.60	0.73	4,793.21	
12,870.00	90.52	271.11	1,827.28	7,788.28	638.94 S	4,858.48 W	1,649,578.35	3,268,128.62	0.76	4,887.93	
12,964.00	88.95	270.79	1,827.71	7,788.71	637.38 S	4,952.46 W	1,649,579.90	3,268,034.64	1.70	4,981.65	
13,059.00	89.05	270.42	1,829.37	7,790.37	636.38 S	5,047.44 W	1,649,580.91	3,267,939.66	0.40	5,076.40	
13,154.00	89.54	269.97	1,830.54	7,791.54	636.06 S	5,142.43 W	1,649,581.23	3,267,844.67	0.70	5,171.20	
13,249.00	90.00	270.06	1,830.92	7,791.92	636.03 S	5,237.43 W	1,649,581.25	3,267,749.68	0.49	5,266.03	
13,343.00	90.92	270.16	1,830.17	7,791.17	635.85 S	5,331.43 W	1,649,581.44	3,267,655.68	0.98	5,359.85	
13,438.00	89.82	270.52	1,829.55	7,790.55	635.29 S	5,426.42 W	1,649,582.00	3,267,560.69	1.22	5,454.64	
13,533.00	90.31	270.60	1,829.45	7,790.45	634.36 S	5,521.42 W	1,649,582.93	3,267,465.70	0.52	5,549.41	
13,628.00	88.89	270.94	1,830.11	7,791.11	633.08 S	5,616.40 W	1,649,584.20	3,267,370.71	1.54	5,644.16	
13,723.00	89.45	271.39	1,831.49	7,792.49	631.15 S	5,711.37 W	1,649,586.14	3,267,275.75	0.76	5,738.84	
13,818.00	90.62	271.65	1,831.43	7,792.43	628.63 S	5,806.34 W	1,649,588.66	3,267,180.78	1.26	5,833.49	
13,913.00	89.17	271.68	1,831.60	7,792.60	625.87 S	5,901.30 W	1,649,591.42	3,267,085.83	1.53	5,928.11	
14,007.00	89.60	271.79	1,832.61	7,793.61	623.02 S	5,995.25 W	1,649,594.26	3,266,991.88	0.47	6,021.73	
14,102.00	88.68	270.30	1,834.04	7,795.04	621.29 S	6,090.22 W	1,649,595.99	3,266,896.91	1.84	6,116.42	
14,197.00	88.49	269.66	1,836.38	7,797.38	621.33 S	6,185.19 W	1,649,595.96	3,266,801.94	0.70	6,211.23	
14,292.00	89.01	269.55	1,838.45	7,799.45	621.98 S	6,280.16 W	1,649,595.31	3,266,706.97	0.56	6,306.07	
14,387.00	89.38	269.08	1,839.79	7,800.79	623.12 S	6,375.15 W	1,649,594.17	3,266,611.99	0.63	6,400.95	
14,482.00	89.82	268.79	1,840.45	7,801.45	624.88 S	6,470.13 W	1,649,592.40	3,266,517.01	0.55	6,495.87	
14,576.00	90.49	268.87	1,840.20	7,801.20	626.80 S	6,564.11 W	1,649,590.49	3,266,423.03	0.72	6,589.80	
14,671.00	90.06	269.44	1,839.74	7,800.74	628.20 S	6,659.09 W	1,649,589.08	3,266,328.05	0.75	6,684.70	
14,766.00	91.20	270.78	1,838.70	7,799.70	628.02 S	6,754.09 W	1,649,589.27	3,266,233.06	1.85	6,779.51	
14,861.00	89.54	271.12	1,838.08	7,799.08	626.44 S	6,849.07 W	1,649,590.84	3,266,138.08	1.78	6,874.23	
14,956.00	89.38	270.53	1,838.98	7,799.98	625.08 S	6,944.05 W	1,649,592.21	3,266,043.10	0.64	6,968.96	
15,051.00	88.21	270.06	1,840.98	7,801.98	624.59 S	7,039.03 W	1,649,592.70	3,265,948.12	1.33	7,063.74	
15,146.00	87.20	269.24	1,844.78	7,805.78	625.17 S	7,133.95 W	1,649,592.12	3,265,853.21	1.37	7,158.53	
15,240.00	88.83	269.13	1,848.04	7,809.04	626.50 S	7,227.88 W	1,649,590.78	3,265,759.28	1.74	7,252.37	
15,335.00	90.15	269.53	1,848.88	7,809.88	627.61 S	7,322.87 W	1,649,589.67	3,265,664.29	1.45	7,347.26	
15,430.00	92.22	271.65	1,846.92	7,807.92	626.64 S	7,417.83 W	1,649,590.65	3,265,569.33	3.12	7,441.99	

Design Report for Thunder 5-64 15-16-1CHZ - Final Surveys

Measured Depth (usft)	Inclination (°)	Grid Azimuth (°)	TVD below System (usft)	Vertical Depth (usft)	Local Coordinates		Map Coordinates		Dogleg Rate (°/100usft)	Vertical Section (usft)	Comments
					Northing (usft)	Easting (usft)	Northing (usft)	Easting (usft)			
15,525.00	90.49	271.47	1,844.67	7,805.67	624.05 S	7,512.77 W	1,649,593.23	3,265,474.40	1.83	7,536.61	
15,619.00	90.03	270.88	1,844.25	7,805.25	622.12 S	7,606.74 W	1,649,595.16	3,265,380.42	0.80	7,630.30	
15,714.00	89.75	270.91	1,844.43	7,805.43	620.64 S	7,701.73 W	1,649,596.65	3,265,285.44	0.30	7,725.03	
15,809.00	90.68	269.89	1,844.07	7,805.07	619.98 S	7,796.73 W	1,649,597.31	3,265,190.44	1.45	7,819.82	
15,904.00	88.80	270.64	1,844.50	7,805.50	619.54 S	7,891.72 W	1,649,597.75	3,265,095.45	2.13	7,914.62	
15,999.00	88.55	270.70	1,846.70	7,807.70	618.43 S	7,986.69 W	1,649,598.86	3,265,000.49	0.27	8,009.35	
16,094.00	88.74	270.49	1,848.95	7,809.95	617.44 S	8,081.66 W	1,649,599.84	3,264,905.52	0.30	8,104.09	
16,189.00	88.77	269.38	1,851.01	7,812.01	617.55 S	8,176.63 W	1,649,599.74	3,264,810.55	1.17	8,198.90	
16,283.00	88.83	268.98	1,852.98	7,813.98	618.89 S	8,270.60 W	1,649,598.39	3,264,716.58	0.43	8,292.79	
16,378.00	90.18	271.29	1,853.80	7,814.80	618.67 S	8,365.59 W	1,649,598.62	3,264,621.60	2.82	8,387.59	
16,473.00	91.11	271.74	1,852.73	7,813.73	616.16 S	8,460.55 W	1,649,601.13	3,264,526.64	1.09	8,482.23	
16,568.00	89.57	271.71	1,852.17	7,813.17	613.30 S	8,555.50 W	1,649,603.99	3,264,431.69	1.62	8,576.85	
16,663.00	89.75	271.40	1,852.73	7,813.73	610.72 S	8,650.46 W	1,649,606.56	3,264,336.73	0.38	8,671.49	
16,758.00	90.18	270.58	1,852.79	7,813.79	609.08 S	8,745.45 W	1,649,608.21	3,264,241.74	0.97	8,766.20	
16,853.00	90.89	270.58	1,851.90	7,812.90	608.12 S	8,840.44 W	1,649,609.17	3,264,146.76	0.75	8,860.97	
16,948.00	89.41	271.32	1,851.65	7,812.65	606.54 S	8,935.42 W	1,649,610.74	3,264,051.78	1.74	8,955.69	
17,042.00	89.91	271.72	1,852.21	7,813.21	604.05 S	9,029.39 W	1,649,613.24	3,263,957.81	0.68	9,049.34	
17,137.00	90.40	271.89	1,851.95	7,812.95	601.06 S	9,124.34 W	1,649,616.23	3,263,862.86	0.55	9,143.94	
17,232.00	89.97	271.75	1,851.65	7,812.65	598.04 S	9,219.29 W	1,649,619.25	3,263,767.91	0.48	9,238.55	
17,327.00	88.61	270.24	1,852.82	7,813.82	596.39 S	9,314.26 W	1,649,620.90	3,263,672.94	2.14	9,333.25	
17,422.00	89.45	269.75	1,854.43	7,815.43	596.40 S	9,409.25 W	1,649,620.89	3,263,577.96	1.02	9,428.07	
17,516.00	90.43	270.26	1,854.53	7,815.53	596.39 S	9,503.25 W	1,649,620.89	3,263,483.96	1.18	9,521.90	
17,611.00	89.78	270.01	1,854.36	7,815.36	596.17 S	9,598.25 W	1,649,621.12	3,263,388.97	0.73	9,616.72	
17,706.00	90.68	270.08	1,853.97	7,814.97	596.09 S	9,693.25 W	1,649,621.19	3,263,293.97	0.95	9,711.54	
17,801.00	89.75	270.08	1,853.62	7,814.62	595.96 S	9,788.24 W	1,649,621.33	3,263,198.98	0.98	9,806.36	
17,896.00	90.49	270.33	1,853.42	7,814.42	595.62 S	9,883.24 W	1,649,621.67	3,263,103.98	0.82	9,901.17	
17,923.00	90.98	270.22	1,853.07	7,814.07	595.49 S	9,910.24 W	1,649,621.80	3,263,076.98	1.86	9,928.11	Last Sperry MWD Survey @ 17923.00' MD
17,991.00	90.98	270.22	1,851.91	7,812.91	595.23 S	9,978.23 W	1,649,622.06	3,263,008.99	0.00	9,995.97	Straight Line Projection to TD @ 17991.00' MD

Design Annotations

Measured Depth (usft)	Vertical Depth (usft)	Local Coordinates		Comment
		+N/-S (usft)	+E/-W (usft)	
27.00	27.00	0.00	0.00	Ground Level Assumed Vertical @ 27.00' MD
328.00	328.00	0.28	1.26	First BH MWD Survey @ 328.00' MD
2,097.00	2,088.91	-115.70	74.40	Last BH MWD Survey @ 2097.00' MD
2,097.00	2,088.91	-115.70	74.40	Tie-On to Last Surface Survey @ 2097.00' MD
2,238.00	2,228.94	-128.79	84.44	First Sperry MWD Survey @ 2238.00' MD
17,923.00	7,814.07	-595.49	-9,910.24	Last Sperry MWD Survey @ 17923.00' MD
17,991.00	7,812.91	-595.23	-9,978.23	Straight Line Projection to TD @ 17991.00' MD

Design Report for Thunder 5-64 15-16-1CHZ - Final Surveys

Vertical Section Information

Angle Type	Target	Azimuth (°)	Origin Type	Origin +N/_S (usft)	Origin +E/_W (usft)	Start TVD (usft)
Target	Thunder 5-64 15-16-1CHZ_PBHL E1	266.58	Slot	0.00	0.00	0.00

Survey tool program

From (usft)	To (usft)	Survey/Plan	Survey Tool
27.00	2,097.00	BH Surface Surveys	2_MWD
2,238.00	17,923.00	Sperry MWD Surveys	2_MWD
17,991.00	17,991.00	PTB	Blind (OWSG)

Casing Details

Measured Depth (usft)	Vertical Depth (usft)	Name	Casing Diameter (")	Hole Diameter (")
2,142.00	2,133.61	9 5/8"	9-5/8	13-1/2

Design Report for Thunder 5-64 15-16-1CHZ - Final Surveys

Wellbore Targets

Target Name - hit/miss target - Shape	Dip Angle (°)	Dip Dir. (°)	TVD (usft)	+N/-S (usft)	+E/-W (usft)	Northing (usft)	Easting (usft)	Latitude	Longitude
Thunder 5-64 15-16-1CHZ_BHL Plat	0.00	0.00	0.00	-595.89	-9,978.69	1,649,621.39	3,263,008.54	39.613292	-104.566436
- actual wellpath misses target center by 7812.91usft at 17991.00usft MD (7812.91 TVD, -595.23 N, -9978.23 E)									
- Point									
Thunder 5-64 15-16-1CHZ_LP Plat	0.00	0.00	0.00	-669.12	-165.86	1,649,548.17	3,272,821.13	39.612809	-104.531611
- actual wellpath misses target center by 689.37usft at 0.00usft MD (0.00 TVD, 0.00 N, 0.00 E)									
- Point									
Thunder 5-64 15-16-1CHZ_SHL	0.00	0.00	0.00	0.00	0.00	1,650,217.28	3,272,986.98	39.614641	-104.530997
- actual wellpath hits target center									
- Point									
Thunder 5-64 15-16-1CHZ_WPT_E3	0.00	0.00	7,764.00	-661.85	-1,162.61	1,649,555.44	3,271,824.40	39.612858	-104.535148
- actual wellpath misses target center by 12.25usft at 9172.97usft MD (7764.78 TVD, -649.63 N, -1163.13 E)									
- Point									
Thunder 5-64 15-16-1CHZ_LP E2	0.00	0.00	7,784.00	-669.12	-191.00	1,649,548.17	3,272,795.99	39.612810	-104.531700
- actual wellpath misses target center by 13.67usft at 8199.84usft MD (7770.70 TVD, -665.95 N, -190.73 E)									
- Point									
Thunder 5-64 15-16-1CHZ_LP E1	0.00	0.00	7,789.00	-669.12	-191.00	1,649,548.17	3,272,795.99	39.612810	-104.531700
- actual wellpath misses target center by 18.57usft at 8199.82usft MD (7770.70 TVD, -665.95 N, -190.71 E)									
- Point									
Thunder 5-64 15-16-1CHZ_PBHL E1	0.00	0.00	7,817.00	-595.89	-9,978.69	1,649,621.39	3,263,008.54	39.613292	-104.566436
- actual wellpath misses target center by 4.17usft at 17991.00usft MD (7812.91 TVD, -595.23 N, -9978.23 E)									
- Point									
Thunder 5-64 15-16-1CHZ_PBHL E2	0.00	0.00	7,822.00	-595.89	-9,978.69	1,649,621.39	3,263,008.54	39.613292	-104.566436
- actual wellpath misses target center by 9.13usft at 17991.00usft MD (7812.91 TVD, -595.23 N, -9978.23 E)									
- Point									
Thunder 5-64 15-16-1CHZ_PBHL E3	0.00	0.00	7,822.00	-595.89	-9,978.69	1,649,621.39	3,263,008.54	39.613292	-104.566436
- actual wellpath misses target center by 9.13usft at 17991.00usft MD (7812.91 TVD, -595.23 N, -9978.23 E)									
- Point									

Design Report for Thunder 5-64 15-16-1CHZ - Final Surveys

Directional Difficulty Index

Average Dogleg over Survey: 1.54 °/100usft

Maximum Dogleg over Survey: 13.11 °/100usft at 7,639.00
usft

Net Tortosity applicable to Plans: 0.94 °/100usft

Directional Difficulty Index: 6.853

Audit Info

North Reference Sheet for Sec. 15-T5S-R64W (HNR Re-Stake) - Thunder 5-64 15-16-1CHZ - OWB

All data is in US Feet unless otherwise stated. Directions and Coordinates are relative to Grid North Reference.

Vertical Depths are relative to KB 27' @ 5961.00usft (True 33). Northing and Easting are relative to Thunder 5-64 15-16-1CHZ

Coordinate System is US State Plane 1983, Colorado Central Zone using datum North American Datum 1983, ellipsoid GRS 1980

Projection method is Lambert Conformal Conic (2 parallel)

Central Meridian is -105.500000°, Longitude Origin:0.000000°, Latitude Origin:39.750000°

False Easting: 3,000,000.00usft, False Northing: 1,000,000.00usft, Scale Reduction: 0.99997603

Grid Coordinates of Well: 1,650,217.27 usft N, 3,272,986.98 usft E

Geographical Coordinates of Well: 39° 36' 52.71" N, 104° 31' 51.59" W

Grid Convergence at Surface is: 0.61°

Based upon Minimum Curvature type calculations, at a Measured Depth of 17,991.00usft
the Bottom Hole Displacement is 9,995.97usft in the Direction of 266.59° (Grid).

Magnetic Convergence at surface is: -7.48° (28 June 2018, , BGGM2018)

