ROCKY MOUNTAIN OILFIELD TESTING CENTER

PROJECT TEST RESULTS

BEAM MOUNTED GAS COMPRESSOR
(JACGAS COMPRESSOR)

MARCH 3, 1998

FC970004/97PT23

RMOTC Test Report
Number 97PT23

Jacgas Compressor

Morrison International
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March 3, 1998

Introduction

Gas compressors that mount on the walking beam of an oil well pumping unit have been tried with mixed success for many years. Gas compression at the wellhead instead of further downstream can 'increase both oil and gas production by reducing the casinghead gas pressure. Excess pressure on the annulus of the well reduces fluid inflow and restricts production. In old, shallow wells, the small amount of pressure (50 psi) may be sufficient to prevent the well from producing economically. Other applications include the unloading of water and fluids from gas wells and coal-bed methane wells.

One of the biggest obstacles to wide usage of these compressors is the problem of cold weather operation. These gas compressors are very sensitive to freezing. Check valves and other equipment can freeze during cold weather and can result in significant damage to the compressor and the pumping unit. This tendency toward self-destruction has made domestic producers very leery of beam mounted compressors. Other problems that have been identified are short equipment lifetimes and high maintenance or repair costs.

Morrison International and their Canadian partner, Iron Horse Compression requested a test of a bearn-mounted compressor (the Jacgas Compressor) that appeared to be suited to cold climates. Successful operation would be a great economic benefit to oil and gas producers in the Rocky Mountain region.

Operation

Morrison International's compressor is the first non-lubricated, double or single acting compressor of its type. It mounts on the walking beam of a beam pumping unit and operates by the movement of the walking beam. Its main function is to draw casing-head gas from the well annulus and discharge the compressed gas into the flowline.

Anticipated Benefits

Marginal wells and even those with high productivity, can benefit from compression of natural gas. Depending on the characteristics of the well, production increase may be the result of:

- Increased pump efficiency
- Elimination of gas locking in pump
- Decreased back pressure of formation
- Purging of fluids in flow line (in gas production)

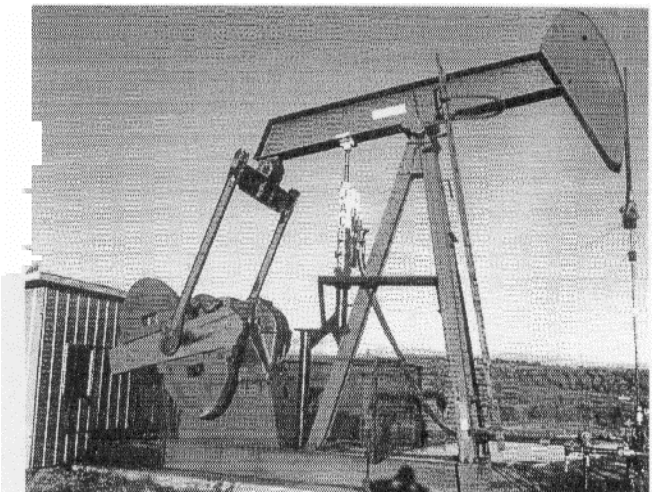
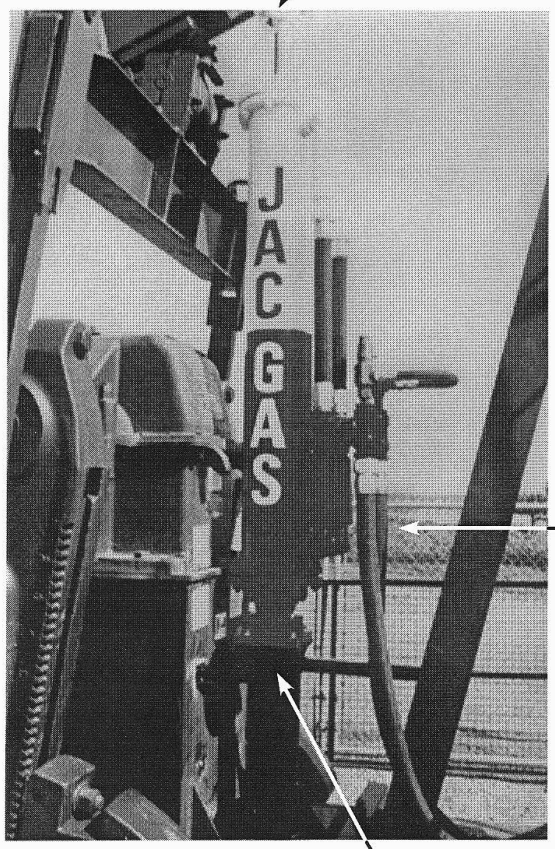


Figure 1 – Jacgas Compressor mounted on pumping unit

Typical Jacgas Compressor installation



Compressor piston connected to walking beam

Suction and discharge hoses - insulated together to conserve heat

Mounting pedestal

If gas is not effectively removed from the wellbore, some free gas may be able to enter the purnp. Depending on the quantity of the gas entering the pump, volumetric efficiency may be reduced or the pump may gas-lock entirely. By allowing the gas to be produced quickly, less free gas is present at the bottom of the well to cause interference.

Also, reduction of well backpressure will allow additional gas and oil to flow from the formation.

Test Program

The goals and acceptance criteria of the test were:

1. Verify the mechanical design and reliability of the pumping equipment under winter conditions.

    - Verify the ability of the unit to operate during winter conditions.

    - Document the maintenance and operating cost during the test.

2. Evaluate the ability of the equipment to increase gas and/or oil production

    - Well should show evidence of a successful application of the technology.

After reviewing production histories and equipment inventories on wells at NPR #3. well 88-AX-28 was selected to be the candidate. This well has a large enough electric motor and pumping unit to handle the additional anticipated load from the compressor. It also had previously had a compressor installed and responded favorably.

TEST RESULTS:

The production history on the well 88-AX-28 showed a modest increase in gas and oil production. Changes in the management of the Second Wall Creek formation, including blowdown of the gas cap and aggressive gas sales have reduced the bottomhole pressure and available gas. This resulted in less response than originally anticipated.

Similar response was noted in 11-AX-34 after it was added on November 20, 1997. A modest increase in production was noted after reducing back pressure on this well also. The second well added on November 20, well 87-AX-28, was not gauged during the test period, so its response to the compressor is unknown.

From a mechanical standpoint, the compressor operated flawlessly from October, 1997 to March, 1998. No downtime, repair or maintenance was necessary during the test period. Labor was confined to data collection and monitoring that was necessary to document the progress of the test.

A complete test chronology as provided as an attachment. Key dates and events during the test include:

October 20, 1997 Started installing compressor at 08:30 hrs. Finished installation at 17:00 hrs. Shot fluid level (91.5 jts down.). 70 psi on backside. 17:30 hrs 28 psi on backside.

November 20, 1997 Well made 1.7 Oil, 28.9 Water and 30.0 mcf on test. Tied 11 Ax 34 and 87 Ax 28 into the compressor.

The two wells mentioned are nearby wells that were not tied into a gas collection system. Since extra compressor capacity existed, a temporary surface flow line was run to the test well in order to collect additional casinghead gas from these wells.

December 1, 1997 Inlet pressure 4 psi, outlet pressure 35 psi. Noticed that the piston rod was turning a little black probably due to packing material wear. The seal is still intact though.

The unit was inspected by company representatives and they determined that wear was within expected limits.

December 9, 1997 Inlet pressure 4 psi, outlet pressure 35 psi. Packing still okay.

March 24, 1998 RMOTC Test terminated. Compressor was removed and stored for the summer. The compressor will be returned to use later in the year when natural gas demand rises.

TECHNICAL OBSERVATIONS:

Criteria 1. Verify the mechanical design and reliability of the pumping equipment under winter conditions.

- Verify the ability of the unit to operate during winter conditions.

  The Jacgas Compressor operated without failure during the winter of 1997-1998, despite winter temperatures below zero fahrenheit and operation of the well on a time clock. This is outstanding performance compared to previous experience at NPR-3.

- Document the maintenance and operating cost during the test.

  No maintenance or repair were necessary during the six month test period. No labor costs were incurred except for data collection required for documentation of the test. Again, this performance is outstanding compared to previous experience at NPR-3 with commercially available alternatives.

2. Evaluate the ability of the equipment to increase gas and/or oil production

- Well should show evidence of a successful application of the technology.

  Casing pressure was on 88-AX-28 reduced from 70 psi initially to 34 psi during operation of the compressor. Additional capacity allowed two additional wells to be tied into the inlet of the compressor.

  The production history on the well 88-AX-28 showed a modest increase in gas and oil production. Similar response was noted in 11-AX-34 after it was added on November 20, 1997.

ACKNOWLEDGEMENTS

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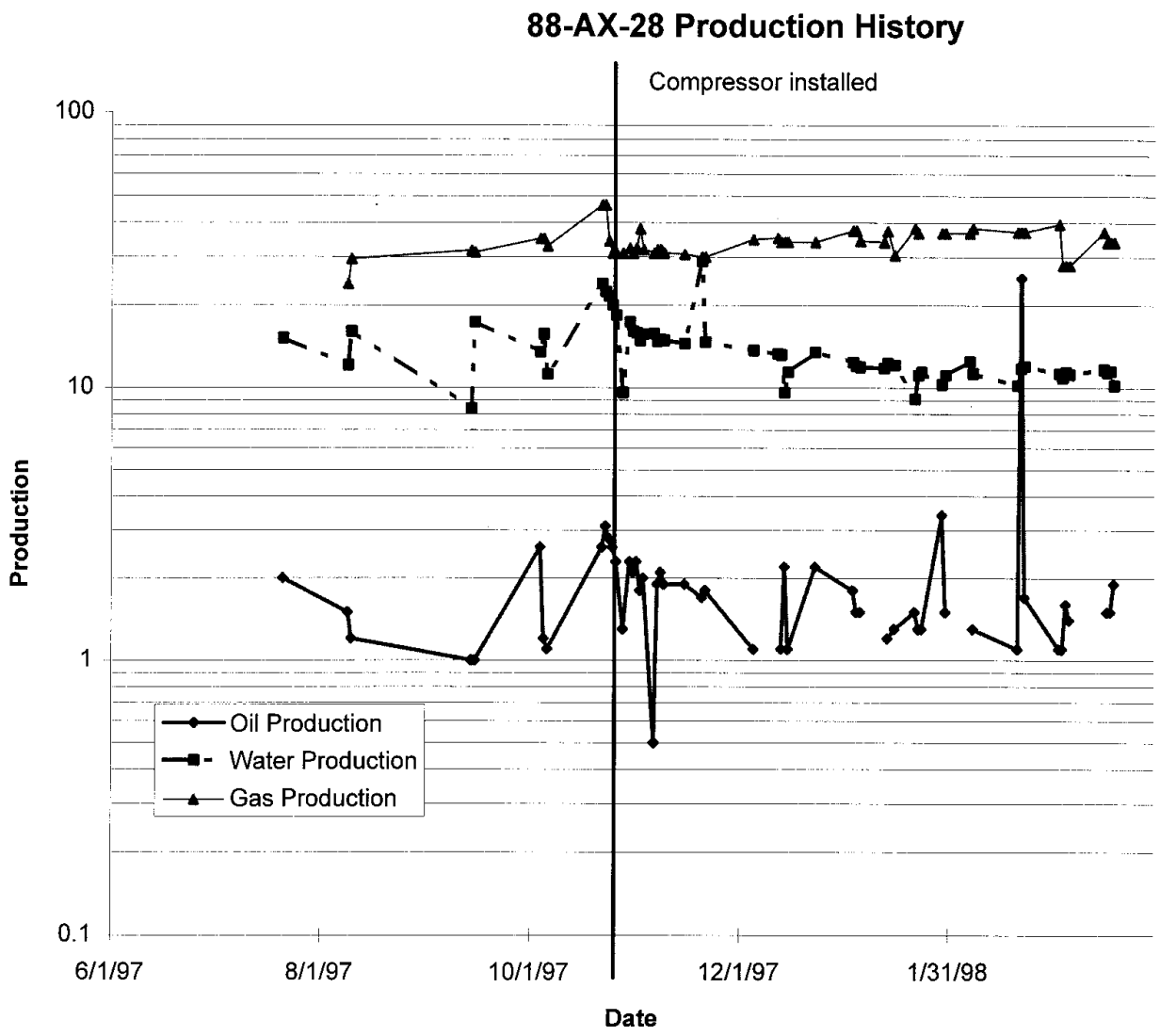
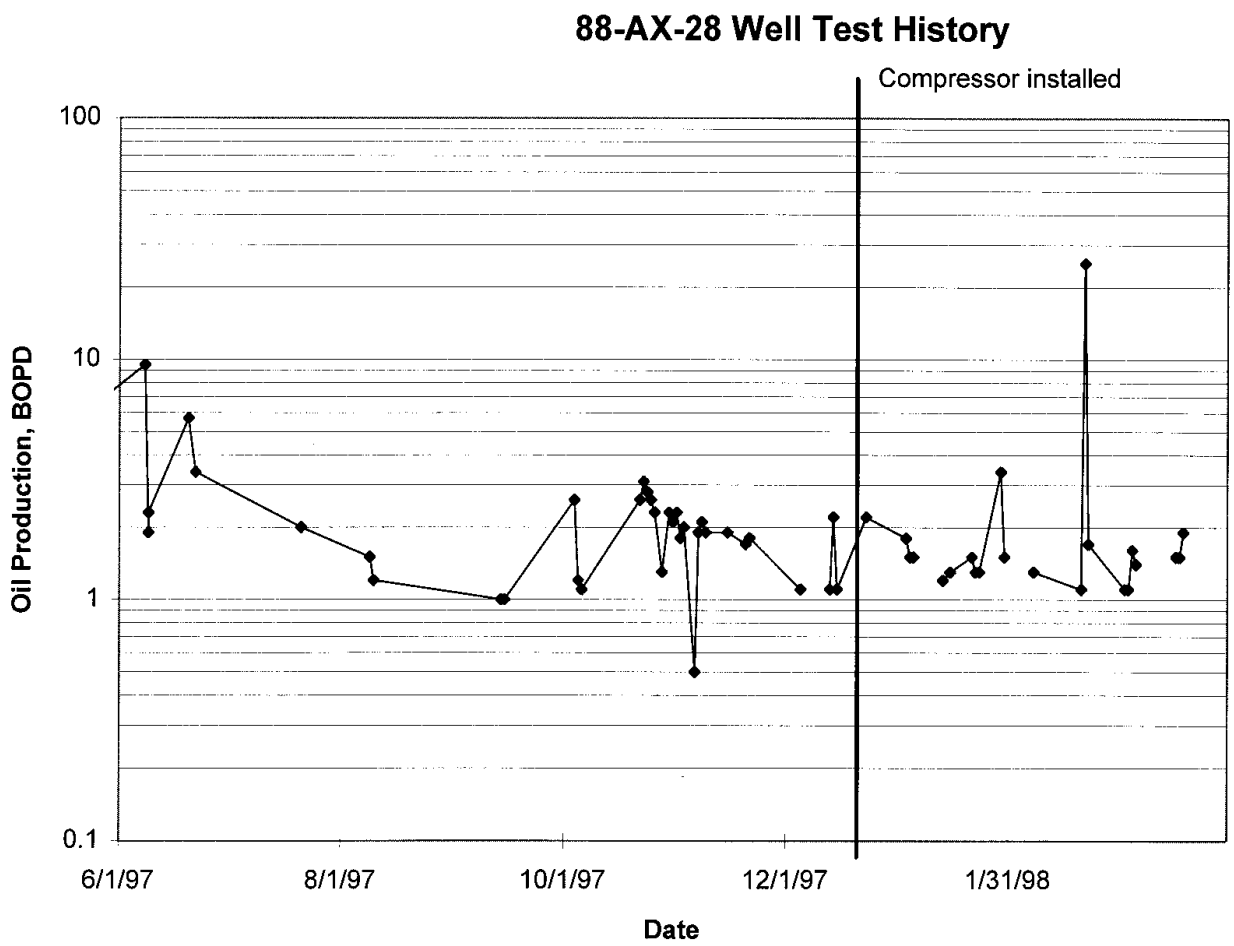
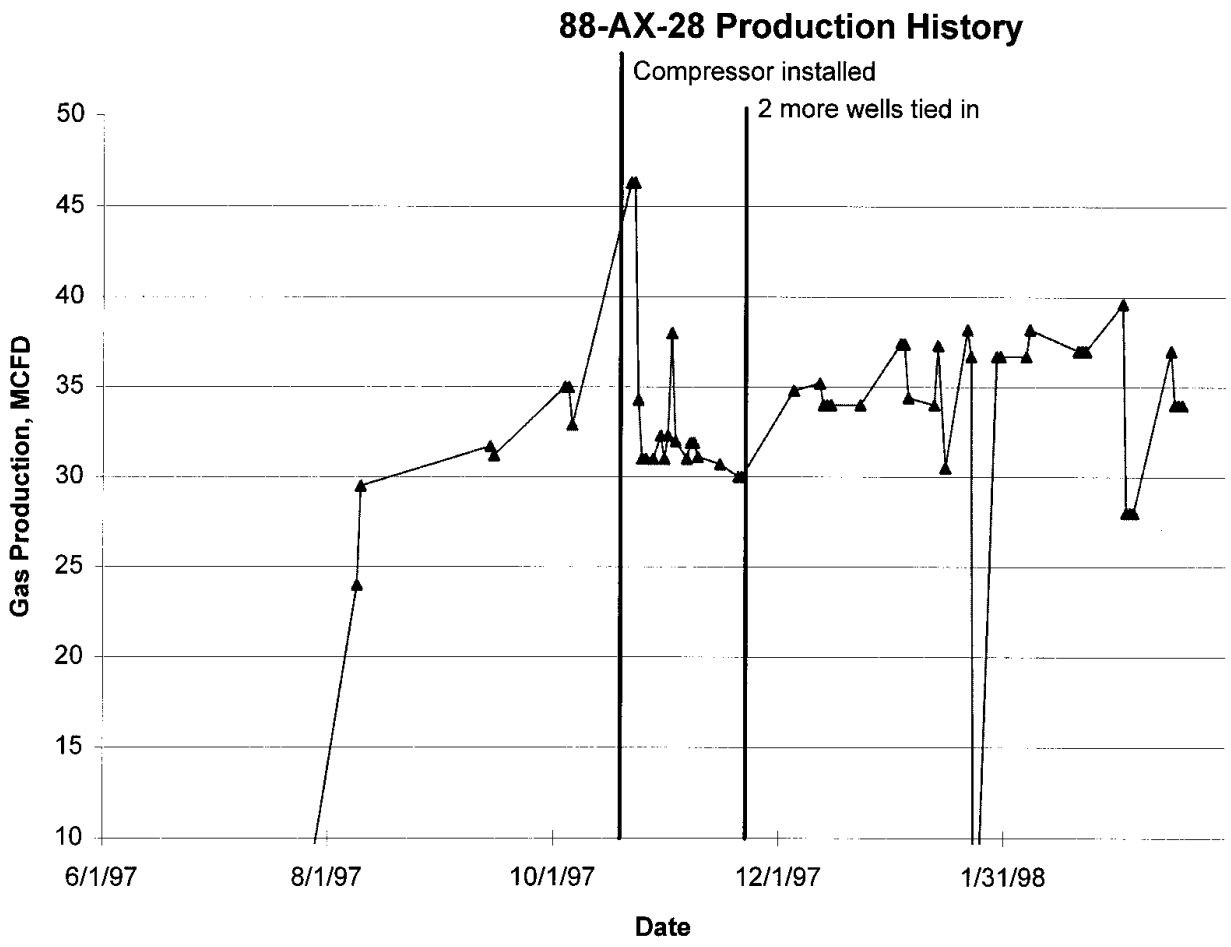
Mountain Oilfield Testing Center (RMOTC). Work was directed by David H. Doyle, PE, RMOTC Project Manager, Brian Meidinger and Dick Webb, RMOTC Field Technicians and Dan Kelly, RMOTC Field Technician. RMOTC is operated by Fluor Daniel (NPOSR), Inc., the Management and Operating Contractor for the Department of Energy Naval Petroleum Oil Shale Reserves in Colorado, Utah, and Wyoming (NPOSR-CUW).

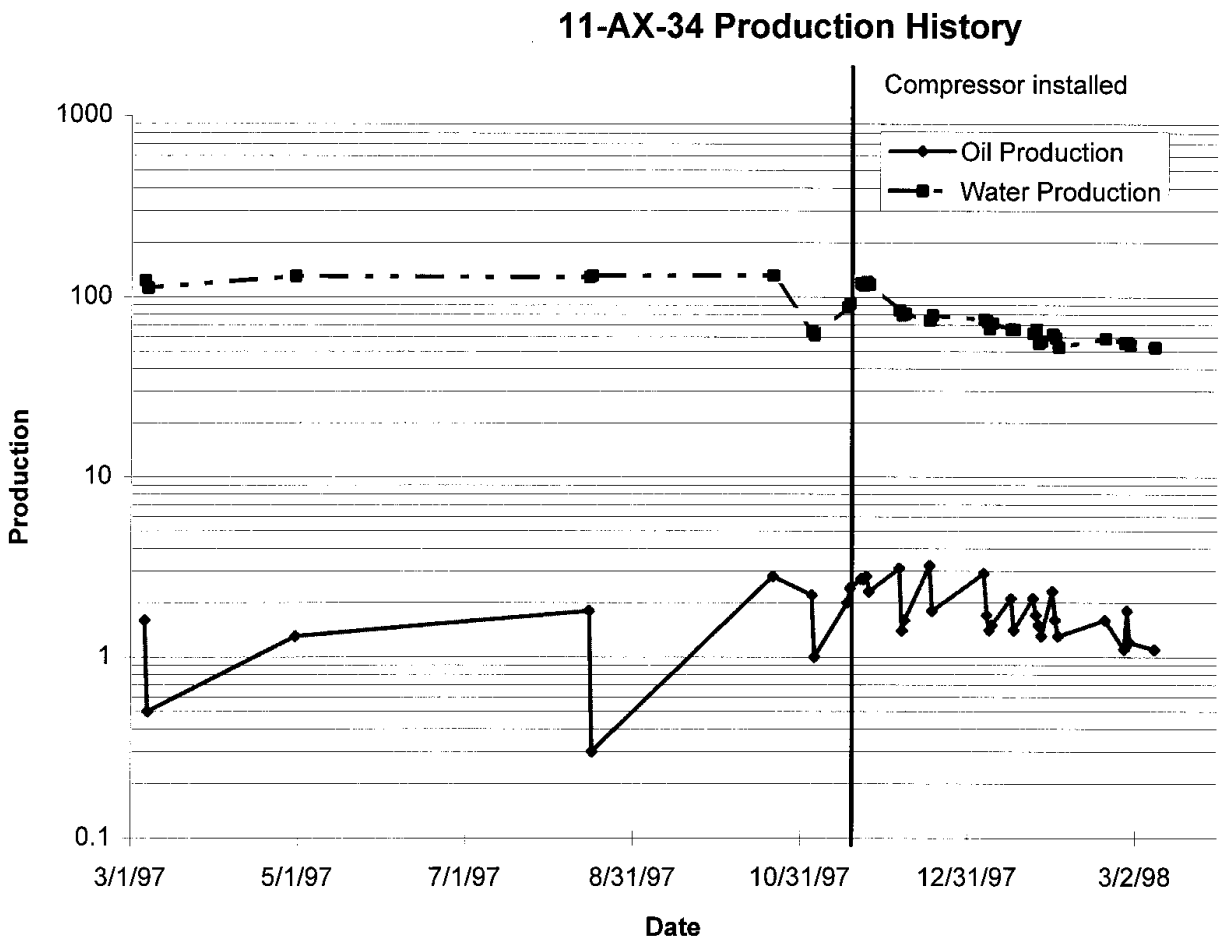
88-AX-28 Well Test History			
Date	Test Oil - BOPD	Test Water - BWPD	Test Gas - MCFD
1/8/97	2.6	16.1	61
1/9/97	1.7	13.9	61
3/11/97	4	11.9	44
3/14/97	4.8	11.3	42
4/10/97	2.7	12.7	43
4/11/97	1.9	13.7	0
6/8/97	9.5	10.3	33.7
6/9/97	1.9	12.3	43
6/9/97	2.3	13.3	31
6/20/97	5.7	11.4	27
6/22/97	3.4	12.1	27
7/21/97	2	15.2	0
8/9/97	1.5	12.1	24
8/10/97	1.2	16.1	29.5
9/14/97	1	8.4	31.7
9/15/97	1	17.4	31.2
10/4/97	2.6	13.5	35
10/5/97	1.2	15.7	35
10/6/97	1.1	11.2	32.9
10/22/97	2.6	24	46.3
10/23/97	3.1	22.4	46.3
10/24/97	2.8	21.6	34.3
10/25/97	2.6	20.1	31
10/26/97	2.3	18.4	31
10/28/97	1.3	9.6	31
10/30/97	2.3	17.4	32.3
10/31/97	2.1	16.1	31
11/1/97	2.3	15.9	32.3
11/2/97	1.8	14.9	38
11/3/97	2	15.7	32
11/6/97	0.5	15.8	31
11/7/97	1.9	14.8	31.9
11/8/97	2.1	15	31.9
11/9/97	1.9	14.9	31.1
11/15/97	1.9	14.5	30.7

88-AX-28 Well Test History			
Date	Test Oil - BOPD	Test Water - BWPD	Test Gas - MCFD
11/20/97	1.7	28.9	30
11/21/97	1.8	14.7	30
12/5/97	1.1	13.7	34.8
12/12/97	0	13.3	35.2
12/13/97	1.1	13.2	34
12/14/97	2.2	9.6	34
12/15/97	1.1	11.4	34
12/23/97	2.2	13.5	34
1/3/98	1.8	12.4	37.4
1/4/98	1.5	12	37.4
1/5/98	1.5	11.9	34.4
1/12/98	0	11.8	34
1/13/98	1.2	12.3	37.3
1/15/98	1.3	12.1	30.5
1/21/98	1.5	9.1	38.2
1/22/98	1.3	11.1	36.7
1/23/98	1.3	11.4	0
1/29/98	3.4	10.3	36.7
1/30/98	1.5	11.1	36.7
2/6/98	0	12.5	36.7
2/7/98	1.3	11.3	38.2
2/20/98	1.1	10.2	37
2/21/98	25.1	11.8	37
2/22/98	1.7	12	37
3/4/98	1.1	11.3	39.6
3/5/98	1.1	10.9	28
3/6/98	1.6	11.4	28
3/7/98	1.4	11.2	28
3/17/98	0	11.7	37
3/18/98	1.5	11.4	34
3/19/98	1.5	11.5	34
3/20/98	1.9	10.2	34


88-AX-28 Production History
Compressor installed
100
10
1
0.1
Production
6/1/97
8/1/97
10/1/97
12/1/97
1/31/98
Date
Oil Production
Water Production
Gas Production


88-AX-28 Well Test History
Compressor installed
100
10
1
0.1
Oil Production, BOPD
6/1/97
8/1/97
10/1/97
12/1/97
1/31/98
Date


88-AX-28 Production History
Compressor installed
2 more wells tied in
Gas Production, MCFD
50
45
40
35
30
25
20
15
10
6/1/97
8/1/97
10/1/97
12/1/97
1/31/98
Date


11-AX-34 Production History
Compressor installed
Oil Production
Water Production
1000
100
10
1
0.1
Production
3/1/97
5/1/97
7/1/97
8/31/97
10/31/97
12/31/97
3/2/98
Date

Iron Horse Compressor **3/30/98**
Gary Refshauge

October 20, 1997- Started installing compressor @ 08:30 hrs. Finished installation @ 17:00 hrs. Shot fluid level (91.5 jts down.). 70 psi on backside. 17:30 hrs 28 psi on backside.
October 21, 1997- 19 psi on backside.
October 22, 1997- Well made 2.6 Oil, 24.0 Water and 46.3 mcf on test.
October 23, 1997- Well made 3.1 Oil, 22.4 Water and 46.3 mcf on test.
October 24, 1997- Well made 2.8 Oil, 21.6 Water and 34.3 mcf on test.
October 25, 1997- Well made 2.6 Oil, 20.1 Water and 34.3 mcf on test.
October 26, 1997- Well made 2.4 Oil, 19.2 Water and 31 mcf on test.
October 27, 1997- Well made 2.5 Oil, 19.2 Water and 31 mcf on test. Started insulating the compressor lines coming from the well going to the compressor. All I have left is on the compressor itself.
October 31, 1997- Well made 2.1 Oil, 16.1 Water and 31 mcf on test.
November 1, 1997- Well made 2.3 Oil, 15.9 Water and 32.3 mcf on test.
November 2, 1997- Well made 1.8 Oil, 14.9 Water and 38 mcf on test.
November 3, 1997- Well made 2.0 Oil, 15.7 Water and 32.0 mcf on test.
November 6, 1997- Well made 0.5 Oil, 15.8 Water and 31 mcf on test.
November 7, 1997- Well made 1.9 Oil, 14.8 Water and 31.9 mcf on test.
November 8, 1997- Well made 2.1 Oil, 15.0 Water and 31.9 mcf on test.
November 9, 1997- Well made 1.9 Oil, 14.9 Water and 31.1 mcf on test.
November 12, 1997- Finished insulating the lines on the compressor.
November 14, 1997- Well made 2.9 Oil, 13.3 Water and 30.0 mcf on test.
November 15, 1997- Well made 1.9 Oil, 14.5 Water and 30.7 mcf on test.
November 19, 1997- Well made 0.1 Oil, 14.8 Water and 30.0 mcf on test.
November 20, 1997- Well made 1.7 Oil, 28.9 Water and 30.0 mcf on test. We tied 11 Ax 34 and 87 Ax 28 into the Ironhorse compressor. After the initial pressure spike the gas went down to virtually nothing. We did see an increase in pressure on the inlet side of the compressor of about 3 psi. The inlet pressure is now just below 6 psi.
November 21, 1997- Well made 1.8 Oil, 14.7 Water and 30.0 mcf on test. Inlet pressure- 6 psi, outlet pressure- 35 psi.
November 26, 1997- Inlet pressure- 5 psi, outlet pressure- 35 psi.
December 1, 1997- Inlet pressure- 4 psi, outlet pressure- 35 psi. Noticed that the piston rod was turning a little black probably due to packing material wear. The seal is still intact though.
December 3, 1997- Inlet pressure- 4 psi, outlet pressure- 35 psi. Talked to Hoyer about installing a low speed motor on unit to decrease the S/M.
December 5, 1997- Well made 1.7 Oil, 13.7 Water and 34.8 mcf on test.
December 9, 1997- Inlet pressure- 4 psi, outlet pressure- 35 psi. Packing still okay.
December 23, 1997- Well made 2.2 Oil, 13.5 Water and 34 mcf on test
January 3, 1998- Well made 1.8 Oil, 12.4 Water 37.4 mcf on test
January 4, 1998- Well made 1.5 Oil 12 Water 37.4 mcf on test
January 5, 1998. Well made 1.5 Oil, 11.9 Water 34.4 mcf on test
January 12, 1998- Well made 0 Oil, 11.8 Water 34 mcf on test Very cold!
January 13, 1998- Well made 1.2 Oil, 12.3 Water, 37.3mcf on test
January 15, 1998- Well made 1.3 Oil, 12.1 Water, 30.5 mcf on test After 10 min Bksd->6 psi
January 21, 1998- Well made 1.5 Oil, 9.1 Water, 38.2 mcf on test. Flowline gauge frozen
January 22, 1998- Well made 1.3 Oil. 11.1 Water, 36.7 mcf on test. 8.5 psi inlet, 35 psi outlet
January 23, 1998- Well made 1.3 Oil, 11.4 Water, 9 psi inlet, 35 psi outlet
January 29, 1998- Well made 3.4 Oil, 10.3 Water, 36.7 mcf on test 9 psi inlet, 35 psi outlet
January 30, 1998- Well made 1.5 Oil, 11.1 Water, 36.7mcf on test 9 psi inlet, 35 psi outlet
February 6, 1998- Well made 0 Oil. 12.5 Water, 36.7mcf on test 8 psi inlet, 32 psi outlet
February 7, 1998- Well made 1.3 Oil. 11.3 Water, 38.2 mcf on test
February 20, 1998-Well made 1.1 Oil, 10.2 Water, 37 mcf on test 6 psi inlet, 30 psi outlet
February 21, 1998- Well made 2.1 Oil, 11.8 Water, 37mcf on test 6 psi inlet. 30 psi outlet
February 22, 1998- Well made 1.7 Oil, 12 Water , 37mcf on test
March 24, 1998 Test Concluded

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Brian L. Meidinger
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