INCIDENT RESPONSE PLAN FOR A HYDROGEN SULFIDE RELEASE

Frontier
Field Services, LLC

Maljamar Operating System
Maljamar, NM

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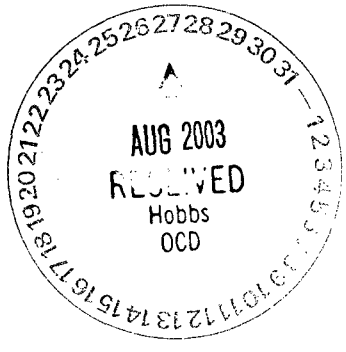

Date
August 28, 2003

H2S INCIDENT RESPONSE PLAN
Table of Contents

A. INTRODUCTION AND PURPOSE

Introduction

It is important that all personnel thoroughly understand that the first and foremost goal in reacting to an emergency is to protect the employees, as well as the public's safety; and secondly, to minimize the damage and other adverse effects of the emergency. It must be kept in mind that in a serious situation involving a Hydrogen Sulfide (H2S) release, not only Frontier Field Services personnel are involved, but local Fire Departments, Law Enforcement, County and even State of New Mexico agencies may be interested parties. Cooperation will expedite all decisions.

In any emergency situation involving a H2S release, delegation of duties will be made to appropriate employees and groups. These duties will be reviewed on an annual basis to ensure complete understanding which will facilitate a well-coordinated response by personnel to the emergency situation.

The Maljamar Gas Plant Measurement office will serve as the Communication Center during the response to an H2S release. If this location must be evacuated, the secondary staging area located at the intersection to Conoco Road and CR 126A will be used to direct activities, utilizing cell phones and company radios. Personnel not directly involved in the response should refrain from using Company Mobile phones, hand held radios and telephones unless absolutely necessary.

Purpose

This H2S Incident Response Plan has been prepared to minimize the hazard resulting from a H2S release. It shall be used to inform company personnel, local emergency responders and the public within an area of exposure to potentially hazardous volume of H2S of actions to be taken before, during and after an H2S release.

The primary concern of Frontier Field Services – Maljamar Gas Plant, during an H2S release, is to protect Company employees, contractors and the public. No individual should place the protection of the Plant Property above his or her own personal safety.

The Incident Command Team will be headed by the Maljamar Plant Manager (Incident Commander) of the Maljamar Plant, or the designated alternate (in the absence of the Plant Manager). He will act as the head of the Incident Command Team and will bear the overall responsibility to see that objectives of the Plan are met. The Plant Manager or Alternate will monitor all activities being carried out. Members of the Maljamar Incident Response Team will keep him informed of conditions throughout the Release emergency.

The Frontier Field Services Maljamar System Operations consists of a 60 Million cubic feet per day cryogenic gas processing plant with H2S treating, 7 field compressor stations (4 are currently in operation) and approximately 650 miles of gathering pipelines which includes approximately 250 miles of low pressure sour (H2S) gas gathering pipelines.

The Frontier Field Services Operations are roughly divided between the OCD Hobbs and Artesia Districts with Plant, pipeline and compressor stations in Chaves, Lea, and Eddy counties. The plant is "manned" 24 hours per day.

Sources of potentially hazardous volumes of H2S gas in the Maljamar Operating System include:

- Low pressure gas gathering pipelines.
- The low pressure inlet area to the Maljamar Plant.
- The amine treater (removes H2S from the inlet gas stream) inside the Maljamar Plant.

Leaks from these sources could create an H2S exposure area. The size of the release, location and concentration will determine if these areas are hazardous. The calculations of the exposure potential and size of the leak is based on a "worst case" scenario. These calculations are based on escape rates as allowed by New Mexico Hydrogen Sulfide standard for existing and new operations. The H2S concentrations were determined by using stain tubes and sample analysis. The Radius of Exposure calculations were done using the Pasquill-Gifford equation.

The calculated Radius of Exposures is located in Appendix C.

REMEMBER

"Remember that the time it takes to complete a job is never so urgent that you cannot spend the time it takes to do the job safely."

B. CONTACT INFORMATION

Maljamar Plant Address: 1001 Conoco Road
P.O. Box 7
Maljamar, NM 88264

Office Telephone Number: 505-676-3501
Plant Control Room: 505-676-3509
Office Fax Number: 505-676-2401
24 hour emergency number: 800-503-5545

Key Contact: **John Prentiss, Plant Manager**
Office: 505-676-3528
Cell: 505-361-0053

Or: **Johnny Lackey, Manager, Compliance**
Office: 505-676-3505
Cell: 505-361-0128

C. COORDINATION WITH STATE EMERGENCY PLANS

Under certain conditions as provided for in the New Mexico Hazardous Materials Emergency Response Plan (HMER), the New Mexico State Police responding to the emergency may elect to assume the position of Incident Commander (IC) or they may establish a unified command of which Frontier Field Services IC may be a key member. Under the Unified Command scenario, Frontier's IC will cooperate with any emergency responders on site, such as the New Mexico State Police, local fire department, Sheriff's Office, NMOCD or other public emergency response agencies to manage a safe response to the emergency situation.

The IC's role is to ensure control of the emergency incident. He will notify or delegate notification to all Frontier or contract personnel and any civil authorities needed to respond to the incident. The IC will assign any additional personnel to support roles as needed. Upon notification or discovery of an H2S release, the following steps should be initiated by the Frontier IC or designee:

1. Assume the role of Incident Commander (IC) and gather as much information as possible regarding the release of H2S.
2. Alert other emergency response personnel of the potential hazard.
3. Arrange for support personnel to be sent to the location of the release.
4. Proceed to the site to assess emergency response actions needed.
5. Set up an on-site command station.
6. Implement the H2S Incident Response Plan as necessary.
7. Remain on site as IC until relieved or the incident is under control.

As part of our Risk Management Plan for the Frontier Field Services Maljamar System we will conduct annual reviews of our RMP and invite the local Sheriff's Department, Fire Departments from Lovington and Maljamar, EMT Services, Emergency Planners from Lea and Eddy counties and State Police to discuss contingency plans.

See additional roles and responsibilities of the Incident Commander in TAB 3 Roles and Responsibilities of Emergency Response Personnel.

EMERGENCY PROCEDURES

A. Discovery and Implementation of Immediate Action Plan

Upon discovery or notification of a potentially hazardous release of H2S, Frontier Field Services employees should immediately activate the following H2S Incident Response Plan:

a. Alert and account for facility personnel
   1. Move away and upwind from the source of the release.
   2. Don personal protective breathing equipment.
   3. Alert other personnel in the area of the potential hazard.
   4. Assist any personnel in distress.
   5. Proceed to the designated emergency assembly area.
   6. Account for personnel on site.

b. Take immediate measures to control the presence of or potential H2S release and eliminate potential ignition sources. Emergency shut down procedures should be initiated as necessary to correct or control the release. When the required action cannot be accomplished in time to prevent exposing operating personnel or the public to hazardous concentrations of H2S take the following steps, as needed for site specific conditions.

c. Alert the public (directly or through appropriate government agencies) that they may be exposed to atmospheres exceeding 30 ppm of H2S.

d. Initiate evacuation operations.

e. Contact the on-call supervisor on the call list. Notify the supervisor of the circumstances and whether immediate assistance is needed. The supervisor should notify (or arrange notification of) other supervisors, Plant Manager and other appropriate personnel (including public officials) on the call list.

f. Make recommendations to public officials regarding blocking unauthorized access to the release area and assist as needed.

g. Make recommendations to public officials regarding the evacuation of the public and assist as needed.

h. Notify, as required, the state, local officials and the National Response Center to comply with release reporting requirements.

i. Monitor the atmosphere in the area of the release (after following abatement measures) to determine when it is safe for re-entry.

B. Initial Response

1. The Frontier Field Services employee (First Responder) at the release site or upon notification of an emergency situation shall immediately proceed to the location and assess the situation and then notify the Incident Commander (IC) or designee of the potential hazard.
   a. Provide the IC with as much data possible concerning the location, the extent of the emergency and the need for additional assistance.
   b. Warn others in the area of the situation and evacuate if necessary.
   c. Remain at the site, at a safe distance upwind of the release and available for communication. Wait for assistance to arrive before attempting to enter the potentially hazardous area.
   d. Provide rescue and first aid assistance as needed.

2. Upon notification of an emergency the IC or designee shall:
   a. Notify other key Emergency Response personnel and alert them to the situation.
   b. The IC will proceed to the site and assess the situation.
   c. The IC will determine if the H2S Incident Response Plan should be initiated.
   d. In the absence of the IC or designee the Frontier Field Services employee at the site will determine if the Plan should be activated and will remain at the scene until relieved by another Frontier Field Services employee or the Civil Authorities.

C. Activation of the H2S Incident Response Plan

The H2S Incident Response Plan will be activated when the release creates a concentration of hydrogen sulfide of more than:

- 100 ppm in any public area.
- 500 ppm at any public road.
- Or 100 ppm ROE is greater than 3000 feet from the site of the release.

It is the responsibility of the Frontier Field Services Incident Commander (IC) to ensure control of the emergency response plan and if necessary to coordinate these efforts with any state or local emergency plans.

D. Evacuation of Public Areas

When an H2S release requires the evacuation of the public from areas which contain or could contain potentially hazardous concentrations of H2S the information regarding the calculated radius of exposures (ROE) contained in Appendix A and C will be utilized. This information will assist in determining the areas of concern at a specific release site. ROE's have been calculated for the Maljamar Gas Plant site, pipeline sections containing H2S gas and field compressor stations that compress H2S gas. Information contained in this plan will be reviewed periodically to ensure accuracy and determine ROE's limits. We will review the plan with State and local emergency responders as part of our annual Incident Response, Right to know training.

E. Training and Drills

Training and drills in emergency response procedures help ensure personnel are adequately prepared to handle most emergency situations. Frontier Field Services personnel will be trained on the H2S Incident Response Plan and procedures annually. Everyone's role and responsibilities will be covered. The need for emergency preparedness will be emphasized through the use of drills and other exercises that simulate an emergency in which personnel perform or demonstrate their roles in the emergency. These drills can be either "table-top" or discussions or realistic drills in which equipment will be deployed and contractors participate. Public officials can be informed and participate in these drills.

Review and critiques of the drills or exercises will be conducted afterward to identify any potential improvement in the plan.

Documentation of the training, drills and reviews will be on file at the Frontier Field Services office at the Maljamar Plant.

Roles and Responsibilities of Incident Response Personnel

Following is a description of key personnel responsibilities for Incident Response.

a. **Incident Commander**.

1. Obtain initial incident briefing from on scene or prior Incident Commander, if available.
2. Assess incident situation and develop appropriate strategies. Conduct site investigations as needed. Establish response priorities.
3. Conduct initial and ongoing briefings with IC staff.
4. Activate elements of the Incident Command System as required.
5. Ensure planning meetings are conducted.
6. Keep Frontier Field Services Line and Senior Management informed of response situation.
7. Manage all Incident operations.
8. Ensure a Frontier Field Services media representative has approved all information releases prior to release or issue.
9. Ensure the safety of all personnel involved in the response.

b. **Operations Section Chief**.

1. Obtain briefing from Incident Commander.
2. Brief and assign operations personnel in accordance with Incident Response needs.
3. Supervise operations; ensure personnel have the equipment, materials supplies and support needed to respond in a safe, efficient and effective manner.
4. Determine Operations Section needs and request additional resources as necessary.
5. Report information about special activities, events and occurrences to the IC.
6. Ensure the safety of all personnel under Operations Section Chief supervision.
7. Ensure site security.

c. **Safety Officer**.

1. Obtain briefing from Incident Commander.
2. Apply for manpower, equipment and services necessary to ensure safe operations at all sites.
3. Ensure hazard communications systems, including MSDS's, are in place at all involved field locations.
4. Identify hazardous situations associated with the incident.
5. Ensure all regulatory requirements as related to safety are satisfied.
6. Ensure that employees and contractors entering the clean-up sites are properly briefed as to the dangers and precautions to be observed at the site. Ensure only those involved in the response are involved in the clean-up of hazardous materials; otherwise, review their training and qualifications.

7. Determine the types of air monitoring equipment (direct reading, personal monitoring, etc.) necessary to support response operations.
8. Participate in planning meetings.
9. Exercise emergency authority to stop and prevent unsafe acts.
10. Lead Incident Investigation Teams for any Incident occurring during or after the emergency. Document and review findings with all team members.

d. **Logistics Section Chief.**

1. Obtain briefing from the Incident Commander.
2. Identify and provide Logistics support for planned and expected operations.
3. Coordinate and process requests for additional resources.
4. Assist Officers and Section Chiefs from other functions in resources procurement.
5. Advise on current service and support capabilities.

e. **Information Officer.**

1. Obtain briefing from Incident Commander.
2. Establish a single incident information center whenever possible.
3. Identify and communicate public, community, and media concerns to the Incident Commander.
4. Respond to special requests for information.

f. **Planning Section Chief.**

1. Obtain briefing from Incident Commander.
2. Reassign initial response and incident personnel into incident positions as needed.
3. Assemble information on alternative strategies.
4. Identify need for use of specialized resources.
5. Advise Incident Command Staff of any significant changes in incident status.
6. Distribute Incident Commander's orders and prepare plans for implementation.

g. **Other Employees.**

All employees on duty should be on stand by awaiting instructions from the Incident Commander. They may be called on to provide support contacting vendors for supplies, contacting local support groups for assistance to the general public, provide on site logistical support to the responders, blocking roads, assist with evacuations, etc.

No employee or contractor will be asked to provide incident scene support that they are not comfortable in their ability to perform or have not been specifically trained to perform.

Frontier
Field Services, LLC

Maljamar Gas Plant
H2S Incident Response Plan
EMERGENCY PHONE NUMBERS

24 Hour Number: 800-503-5545
Maljamar Plant Control Room: 505-676-3509

John Prentiss Plant Manager, Incident Commander	Office...505-676-3528 Cell.....505-361-0053 Home....505-885-1265
Johnny Lackey Manager, Compliance, Safety Officer	Office....505-676-3505 Cell.....505-361-0128 Home.....505-625-8685
Steve Maker Operations, Operations Section Chief	Office.....505-676-3502 Cell.....505-361-3108 Home.....505-396-0308
Rudy Lizardo Maintenance Foreman, Planning Section Chief	Office.....505-676-3504 Cell.....505-361-0135 Home.....505-396-3771
Jerry Wright Measurement Foreman, Information Officer	Office.....505-676-3512 Cell.....505-361-0154 Home.....505-396-5556
Joe Calderon Field Foreman, Logistics Section Chief	Office.....505-676-3506 Cell.....505-361-0148 Home.....505-885-3504

Frontier
Field Services, LLC

TULSA HEADQUARTERS PHONE NUMBERS

Dave Presley, President	Office.....918-492-4450 x302 Cell.....918-637-2419
Jim Lind, Vice President	Office.....918-492-4450 x306 Cell.....918-605-1255
Mike Hicks, Director of Operations	Office.....918-492-4450 x317 Cell.....918-688-5738
Brad Campbell, Manager, Engineering	Office.....918-492-4450 x308 Cell.....918-760-0029

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Maljamar Gas Plant
H2S Incident Response Plan
EMERGENCY PHONE NUMBERS

EMERGENCIES – DIAL 911

LAW ENFORCEMENT:

Hobbs Sheriff's Office	**505-393-2515**
Lovington Sheriff's Office	**505-396-3611**
Carlsbad Sheriff's Office	**505-887-7551**
New Mexico State Police – Lea County	**505-392-5588**
New Mexico State Police – Eddy County	**505-885-3137**

FIRE DEPARTMENTS:

Lovington	**505-396-2359**
Maljamar	**505-676-4100**
Artesia	**505-746-2701**
Hobbs	**505-397-9308**
Loco Hills	**505-677-2181**

AMBULANCE SERVICE:

Artesia	**505-746-2701**
Hobbs	**505-397-7561**
Lovington	**505-396-2359**
Carlsbad	**505-885-2111**
Aero Care – Lubbock	**800-627-2376**

HOSPITALS:

Hobbs – Lea Regional	**505-392-6581**
Lovington – Nor-Lea	**505-396-6611**
Carlsbad – Guadalupe	**505-887-4100**
Lubbock – Methodist	**806-793-4366**
Lubbock – St. Mary's	**806-796-6850**

POISON CONTROL CENTER:

Albuquerque	**800-432-6866**

Frontier
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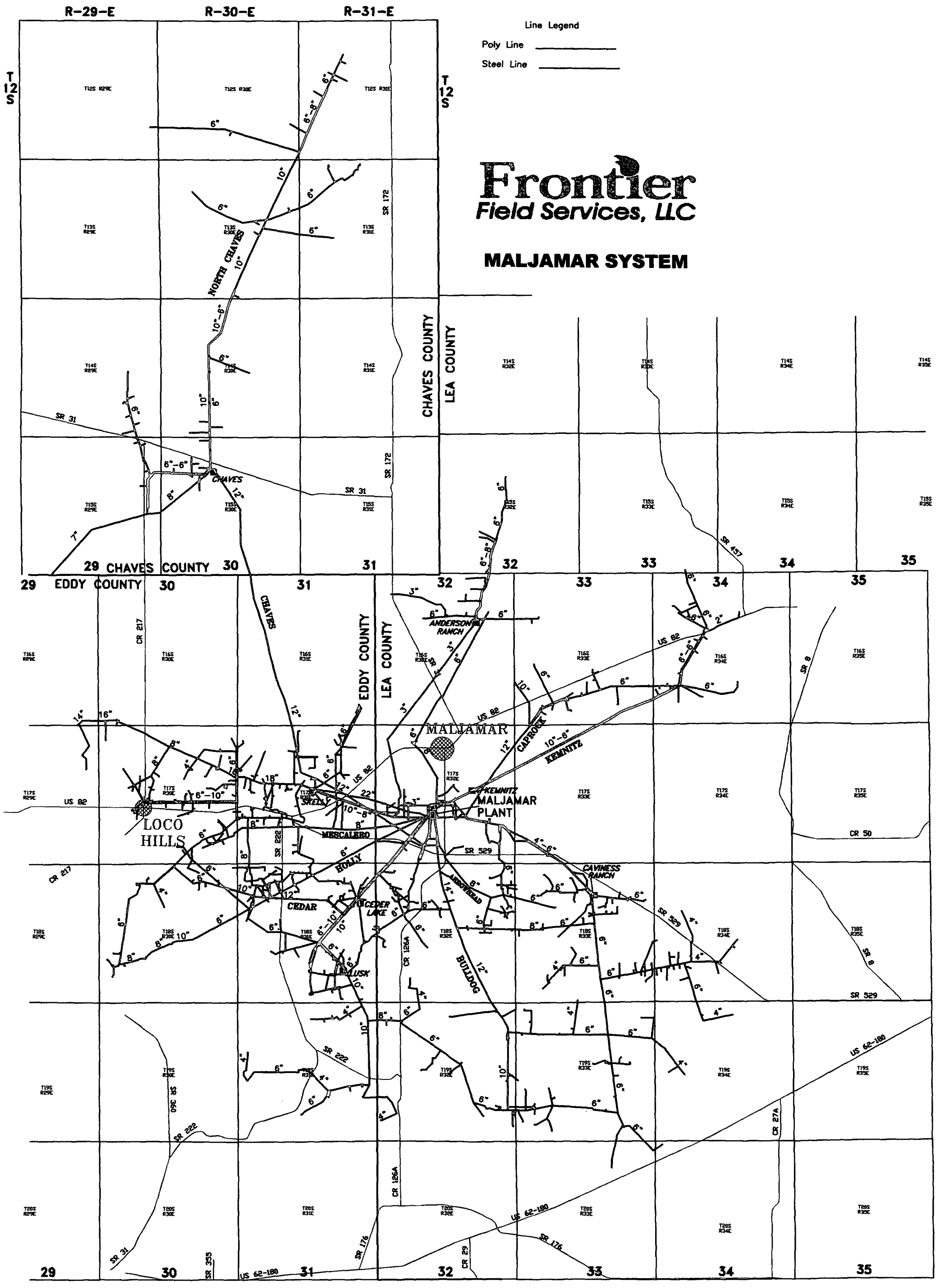
Maljamar Gas Plant
H2S Incident Response Plan
GOVERNMENT AGENCIES

New Mexico Oil Conservation Division	**505-393-6161**
Bureau of Land Management	**505-393-3612**
Air Quality Bureau, Santa Fe, NM	**505-827-1494**

Frontier
Field Services, LLC

Maljamar Gas Plant
H2S Incident Response Plan
CONTRACTOR SUPPORT

COMPANY	SERVICE	CONTACT	PHONE
B&H Construction	Construction/Maint.	Mike Wright	505-887-9755
Cooper Cameron Valves	Valve Repair	Dean Bohannon	915-362-1151
Cubix Corp.	Emissions Testing	Marc McDaniel	512-243-0202
Desert X-Ray	X-Ray Services	Elic Brymer	915-363-0669
E. D. Walton Const.	Construction Services	Wade Lancaster	800-657-9190
Environmental Plus	Spill Remediation	Gabino Rosa	505-394-3481
Ferguson Const.	Construction Services	Mark Wieser	505-396-3689
Fite Fire & Safety	Safety Services	Tim Nolen	915-689-6492
Gandy Corp.	Oilfield Service	Larry Gandy	505-396-4948
Hanover Compression	Compression Service	Vicki Egan	281-447-8787
Hughes Services	Vacuum Service	Donnie Mathews	505-677-3113
Industrial Insulation	Insulation Service	Scott Fulton	915-332-8203
Kenemore Welding	Welding Service	George Kenemore	505-676-2332
Mark's Crane & Rigging	Crane Services	David Landreth	915-337-1538
Mobile Labs	Laboratory Service	Jenny Linley	915-337-4744
Permian Valve Repair	Valve Repair	Raymond Tucker	915-381-1313
Plant Maint. Services	Chemical Cleaning	Dale Carter	432-580-5900
BJ-Coiltec	Nitrogen Services	Stephen Baugh	915-683-1887
Smith & Son's	Construction Service	Randy Smith	505-397-1852
Southwest Safety	Safety Services	Scott Magness	505-392-8080
TWS, Inc.	Crane, Man Lift Service	Randy Gandy	505-398-3811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R-30-E
R-31-E
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Line Legend
Poly Line
Steel Line
Frontier
Field Services, LLC
MALJAMAR SYSTEM
CHAVES COUNTY
LEA COUNTY
EDDY COUNTY
SR 172
SR 31
SR 457
SR 529
SR 222
SR 360
SR 8
US 82
US 62-180
CR 217
CR 50
CR 126A
CR 27A
CR 29
MALJAMAR
MALJAMAR PLANT
LOCO HILLS
ANDERSON RANCH
CAPROCK
KEMNITZ
MESCALERO
HOLLY
CEDAR
CEDAR LAKE
LUSK
BULLDOG
AEROTHREAD
CAVINESS RANCH
SPELLY
CHAVES
29 CHAVES COUNTY 30 31 32 33 34 35
29 EDDY COUNTY 30 31 32 33 34 35

TOWNSHIP 12 SOUTH , RANGE 29 EAST , NMPM
CHAVES COUNTY, NEW MEXICO

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18	17	16	15	14	13
19	20	21	22	23	24
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31	32	33	34	35	36

NO H2S

LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	00-02-02

Frontier
Field Services, LLC

TOWNSHIP 12 SOUTH , RANGE 29 EAST
NMPM , CHAVES COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4680'

Drawing Number
MJ-97342

TOWNSHIP 12 SOUTH , RANGE 30 EAST , NMPM
CHAVES COUNTY, NEW MEXICO

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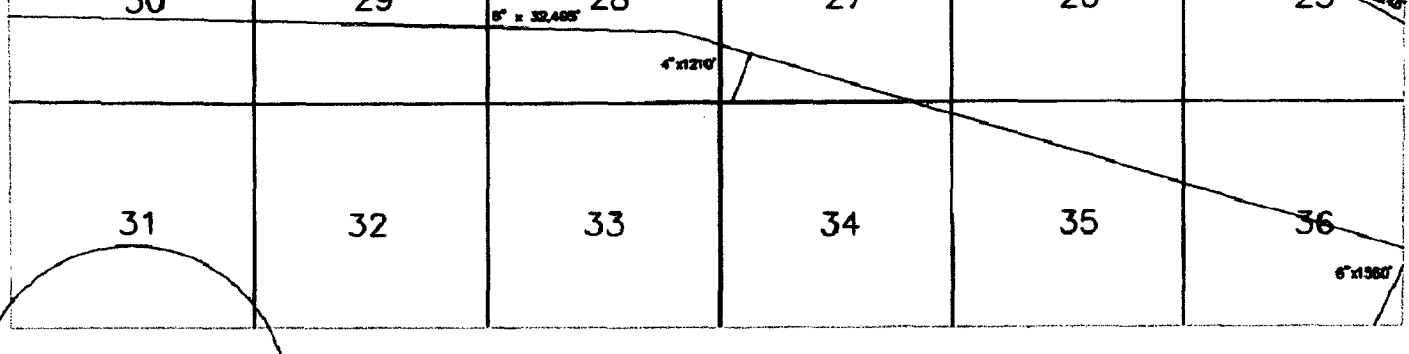

NO H2S

LOCATION ABANDONED

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLB	09-03-03

Frontier Field Services, LLC

TOWNSHIP 12 SOUTH , RANGE 30 EAST
NMPM , CHAVES COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

TOWNSHIP 12 SOUTH , RANGE 31 EAST , NMPM
CHAVES COUNTY, NEW MEXICO

6	5	4	3	2	1
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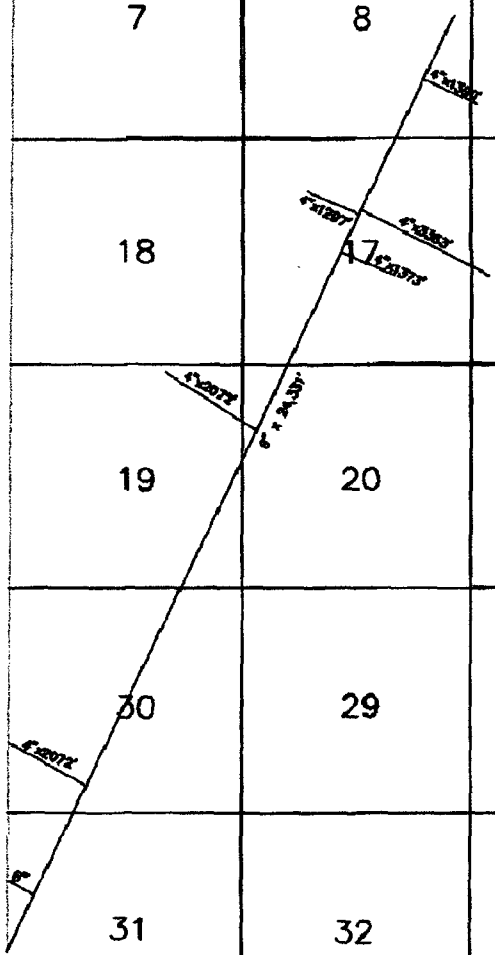


NO H2S

LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	05-10-05

Frontier Field Services, LLC

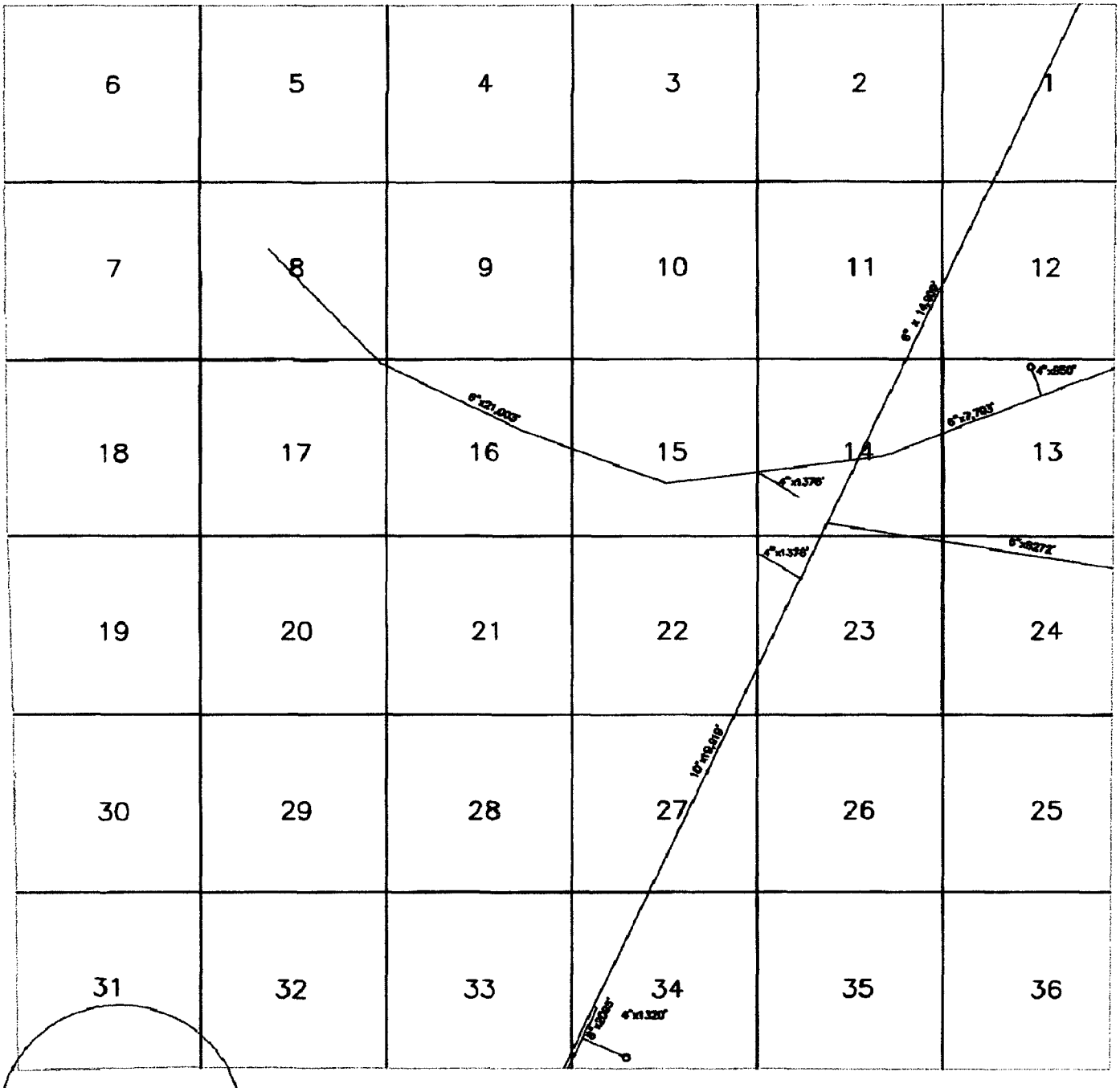
TOWNSHIP 12 SOUTH , RANGE 31 EAST
NMPM, CHAVES COUNTY, NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ-97344

TOWNSHIP 13 SOUTH , RANGE 30 EAST , NMPM
CHAVES COUNTY, NEW MEXICO



NO H2S

USER LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	BLS	06-03-02

Frontier Field Services, LLC

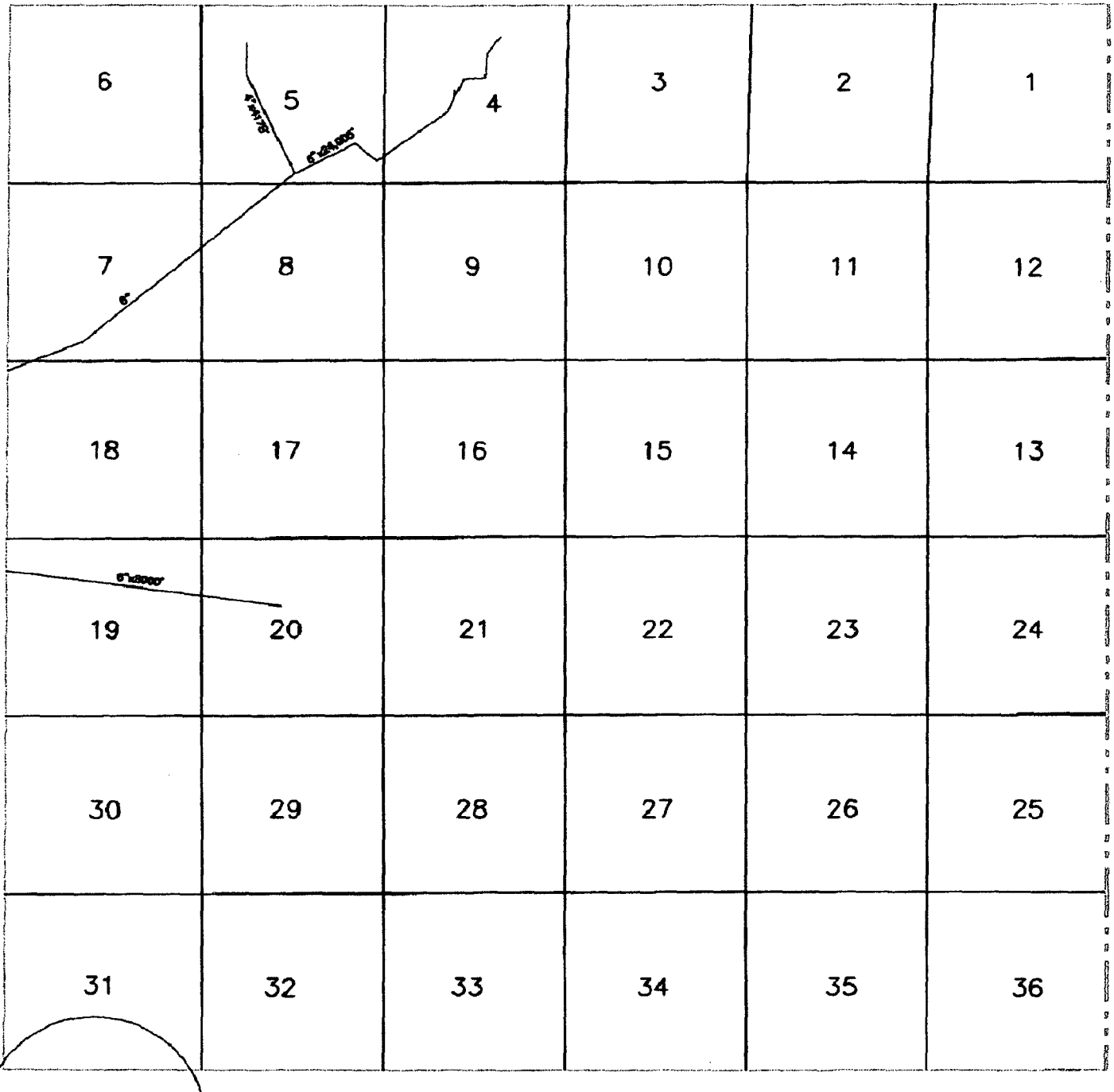
TOWNSHIP 13 SOUTH , RANGE 30 EAST
NMPM , CHAVES COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number MJ-97340

TOWNSHIP 13 SOUTH , RANGE 31 EAST , NMPM
CHAVES COUNTY, NEW MEXICO



NO H2S

LINE LEGEND

POLY LINE

STEEL LINE

RGE BOUNDARY

REV.	BY	DATE
1	RLS	06-03-05

Frontier Field Services, LLC

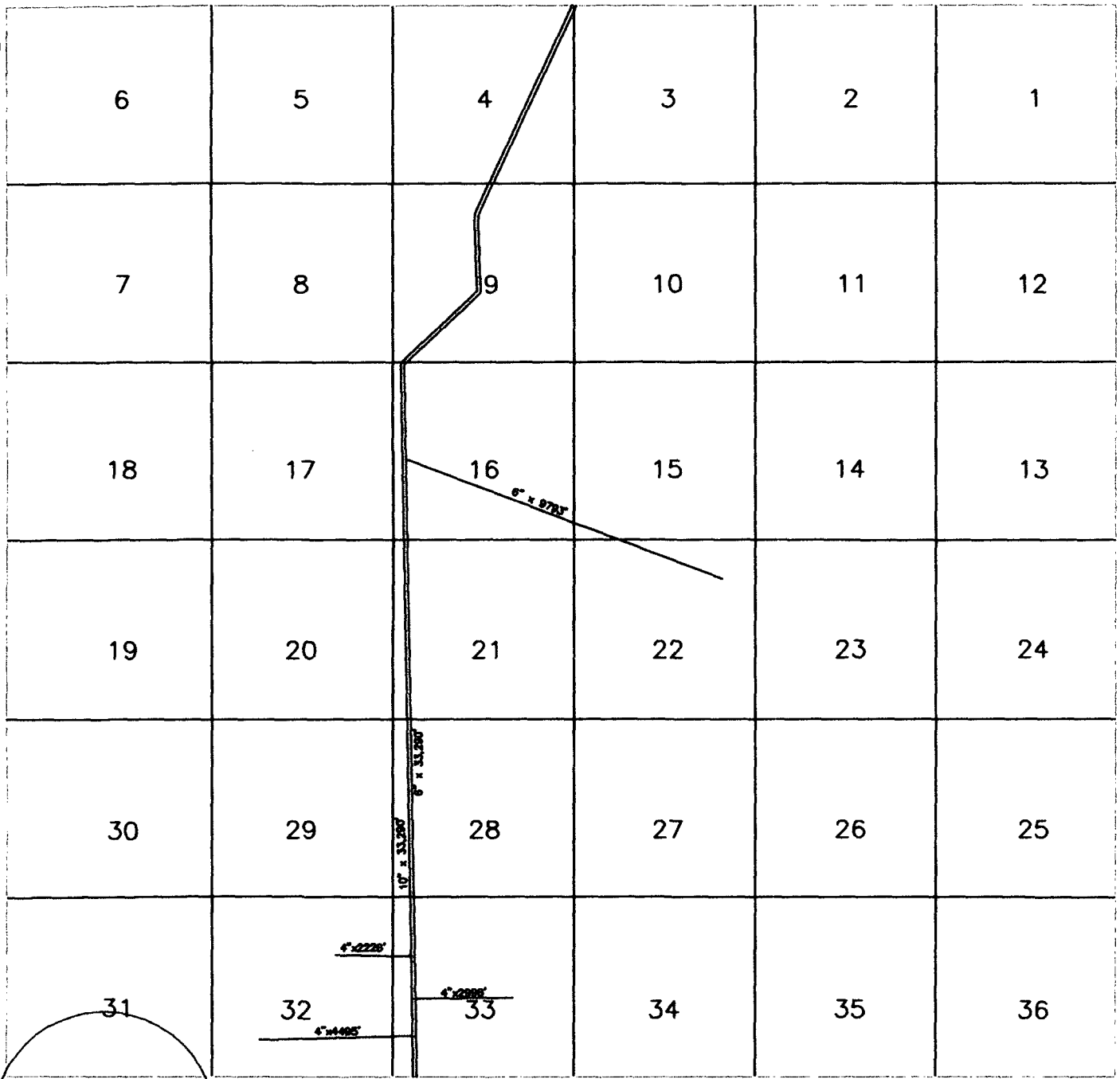
TOWNSHIP 13 SOUTH , RANGE 31 EAST
NMPM , CHAVES COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number MJ-97341

TOWNSHIP 14 SOUTH , RANGE 30 EAST , NMPM
CHAVES COUNTY, NEW MEXICO



NO H2S

LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLB	09-02-03

Frontier Field Services, LLC

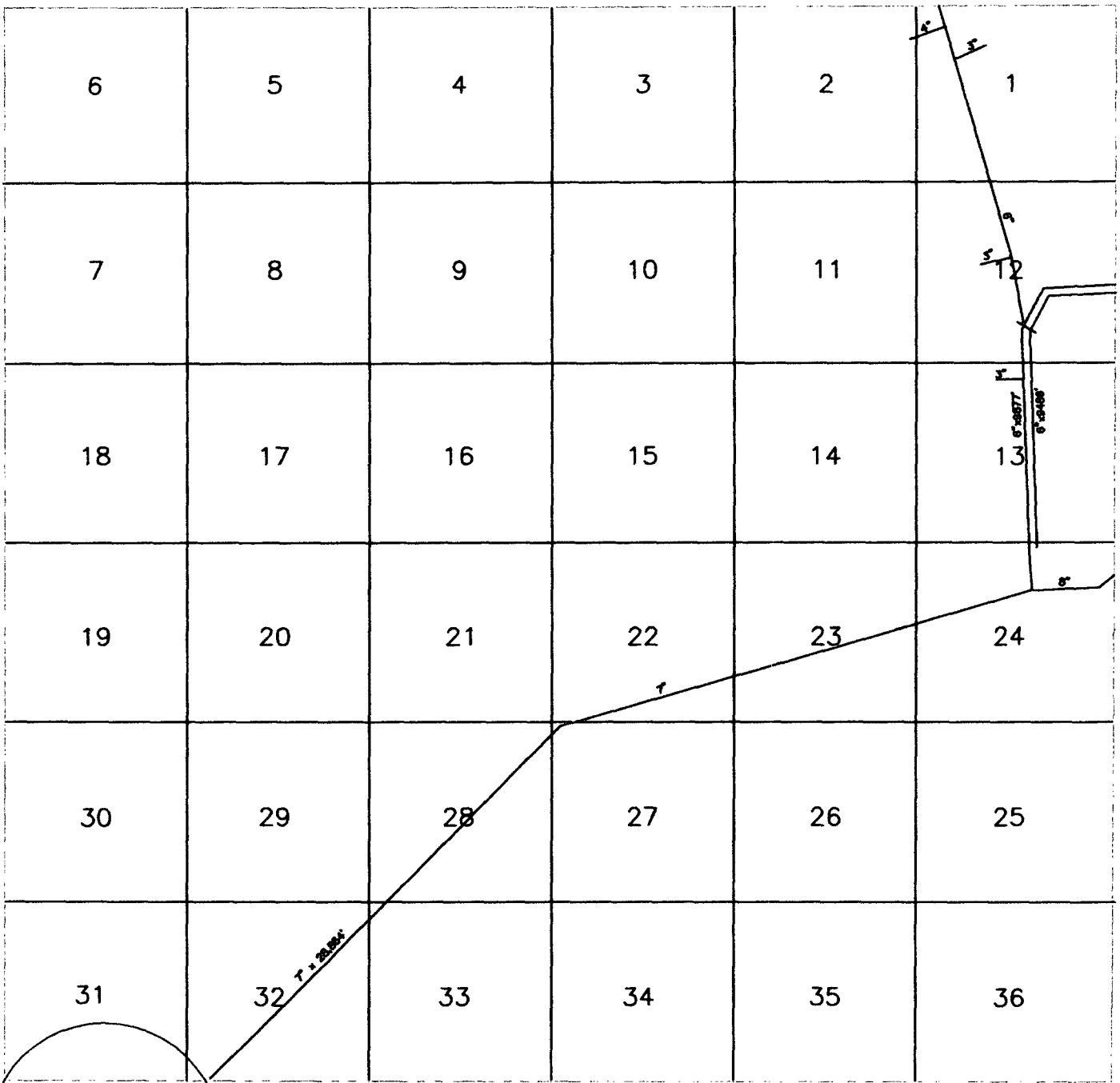
TOWNSHIP 14 SOUTH , RANGE 30 EAST
NMPM , CHAVES COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number MJ_14-30

TOWNSHIP 15 SOUTH , RANGE 29 EAST , NMPM
CHAVES COUNTY, NEW MEXICO



NO H2S

LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
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Frontier Field Services, LLC

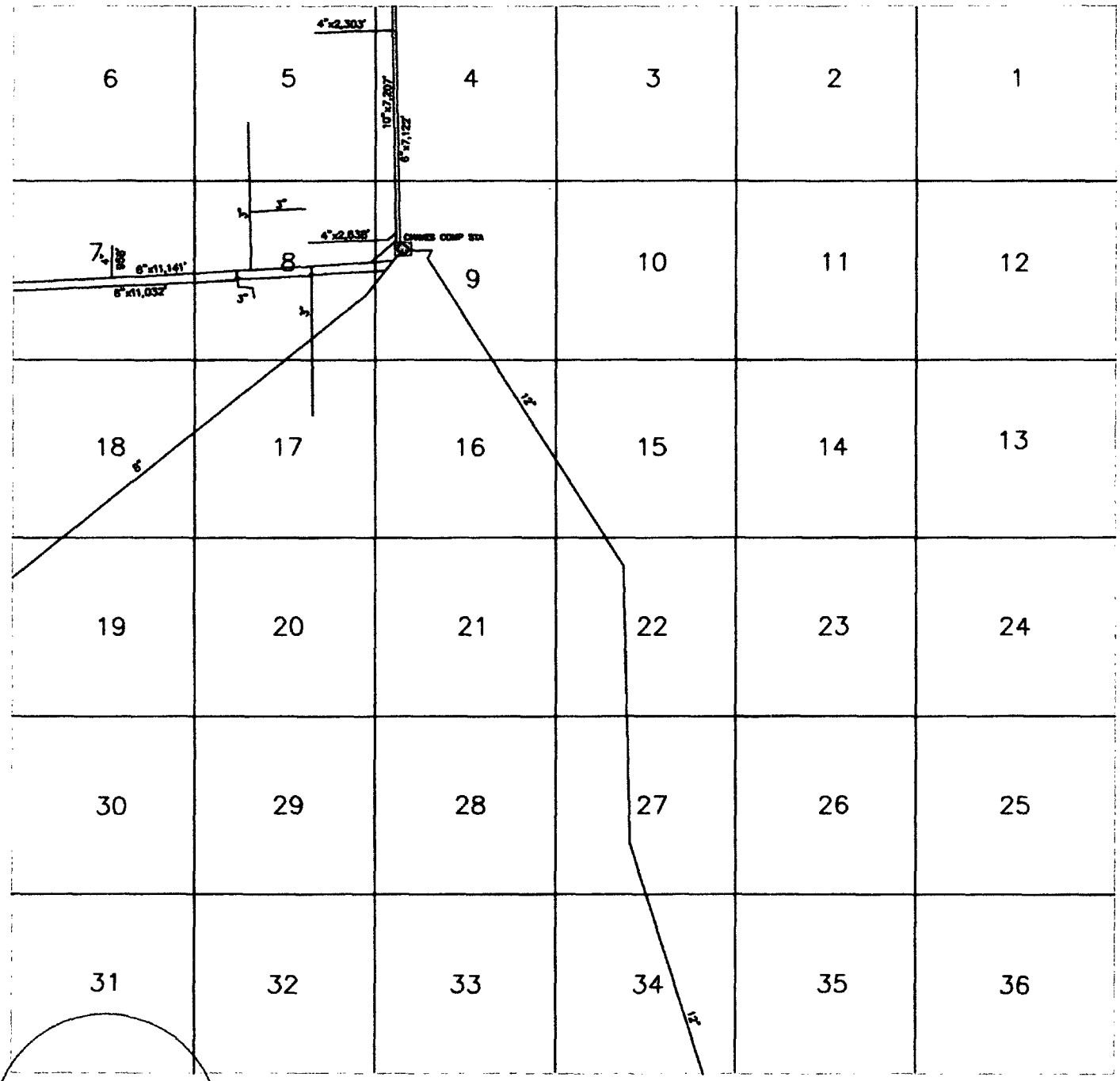
TOWNSHIP 15 SOUTH , RANGE 29 EAST
NMPM , CHAVES COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number MJ_15-29

TOWNSHIP 15 SOUTH , RANGE 30 EAST , NMPM
CHAVES COUNTY, NEW MEXICO



NO H2S

LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	06-03-05

Frontier Field Services, LLC

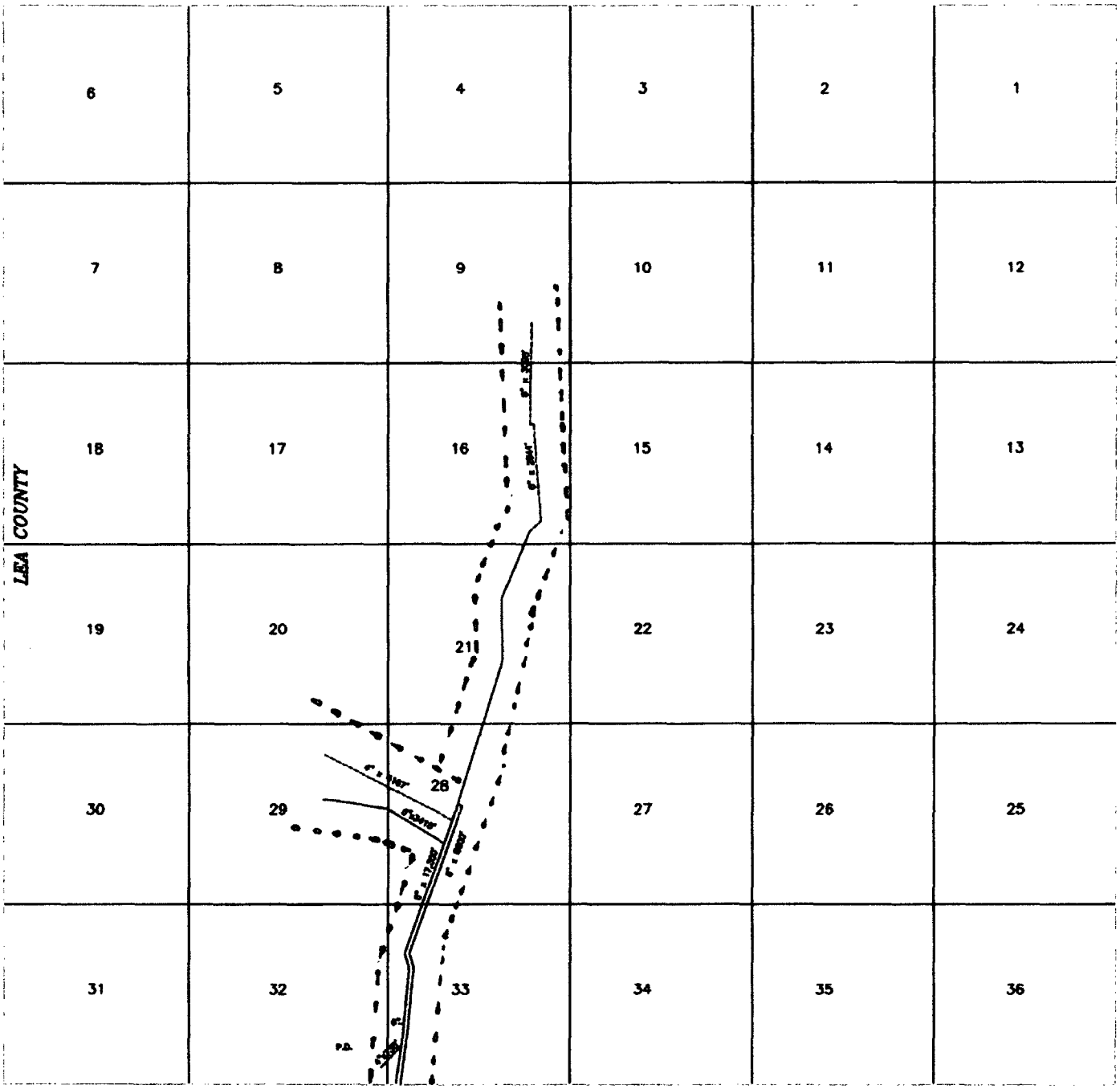
TOWNSHIP 15 SOUTH , RANGE 30 EAST
NMPM , CHAVES COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number MJ_15-30

TOWNSHIP 15 SOUTH , RANGE 32 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	05-03-02

Frontier Field Services, LLC

TOWNSHIP 15 SOUTH , RANGE 32 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4890'

Drawing Number MJ_15-32

TOWNSHIP 15 SOUTH , RANGE 33 EAST , NMPM
LEA COUNTY, NEW MEXICO

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

NO H2S

USER LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLB	08-03-05

Frontier Field Services, LLC

TOWNSHIP 15 SOUTH , RANGE 33 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

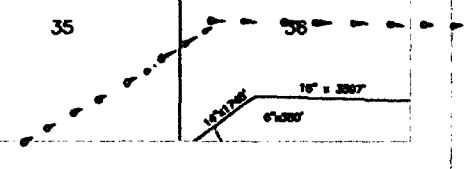
Drawing Number
MJ_15-33

TOWNSHIP 16 SOUTH , RANGE 29 EAST , NMPM
EDDY COUNTY, NEW MEXICO

CHAVES COUNTY

EDDY COUNTY

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



LINE LEGEND

POLY LINE	----------
STEEL LINE	————
ROE BOUNDARY	----------

REV.	BY	DATE
1	GLS	05-02-03

Frontier Field Services, LLC

TOWNSHIP 16 SOUTH , RANGE 29 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

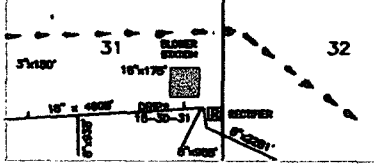
SCALE : 1"=4690'

Drawing Number
MJ_16-29

TOWNSHIP 16 SOUTH , RANGE 30 EAST , NMPM
EDDY COUNTY, NEW MEXICO

CHAVES COUNTY
EDDY COUNTY

6	5	4	3	2	1
7	8	10	11	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



LINE LEGEND

POLY LINE	
STEEL LINE	
ROE BOUNDARY	

REV.	BY	DATE
1	RLB	05-03-05

Frontier Field Services, LLC

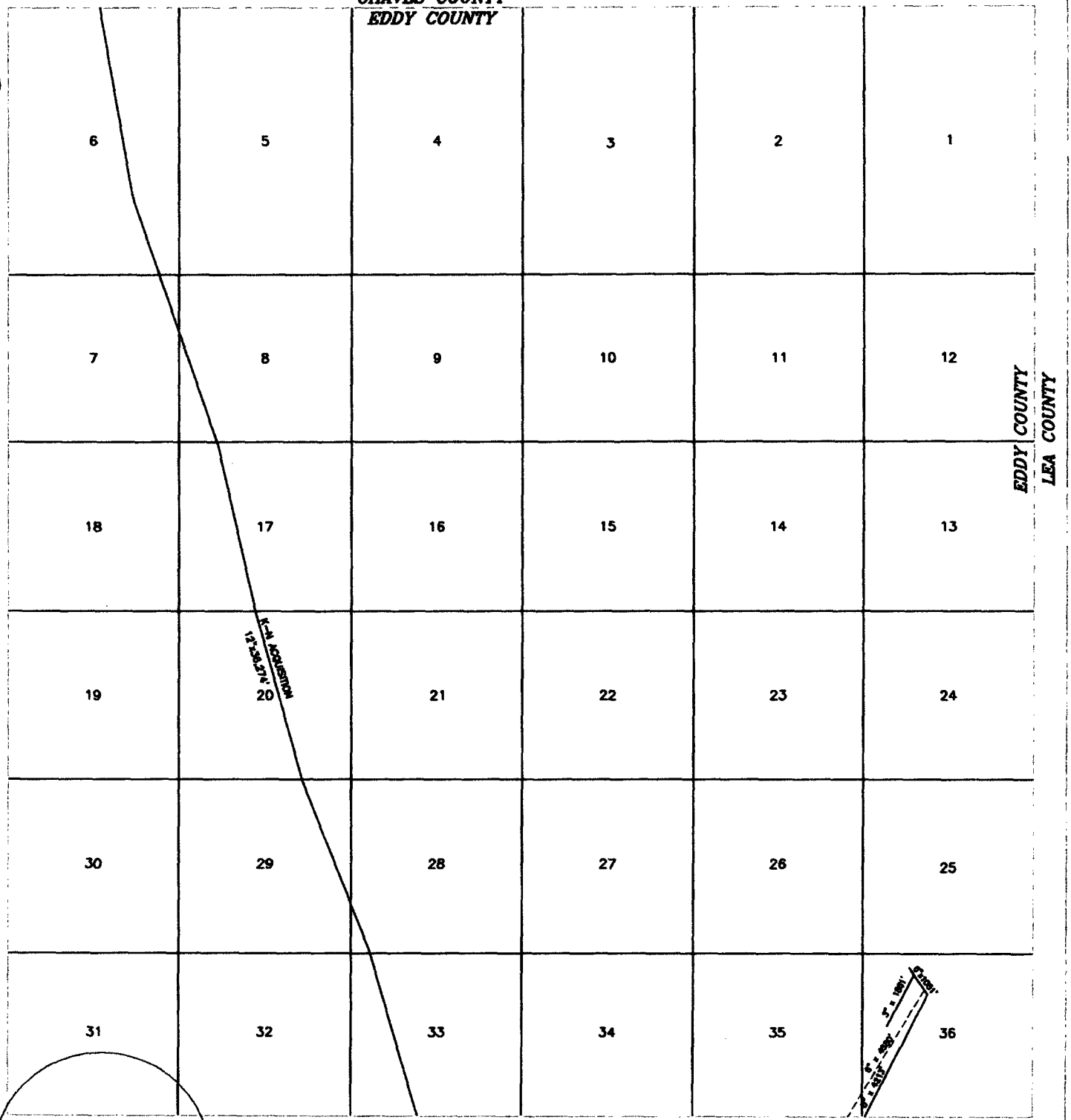
TOWNSHIP 16 SOUTH , RANGE 30 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_16-30

TOWNSHIP 16 SOUTH , RANGE 31 EAST , NMPM
EDDY COUNTY, NEW MEXICO



REV.	BY	DATE
1	RLS	05-03-03

Frontier Field Services, LLC

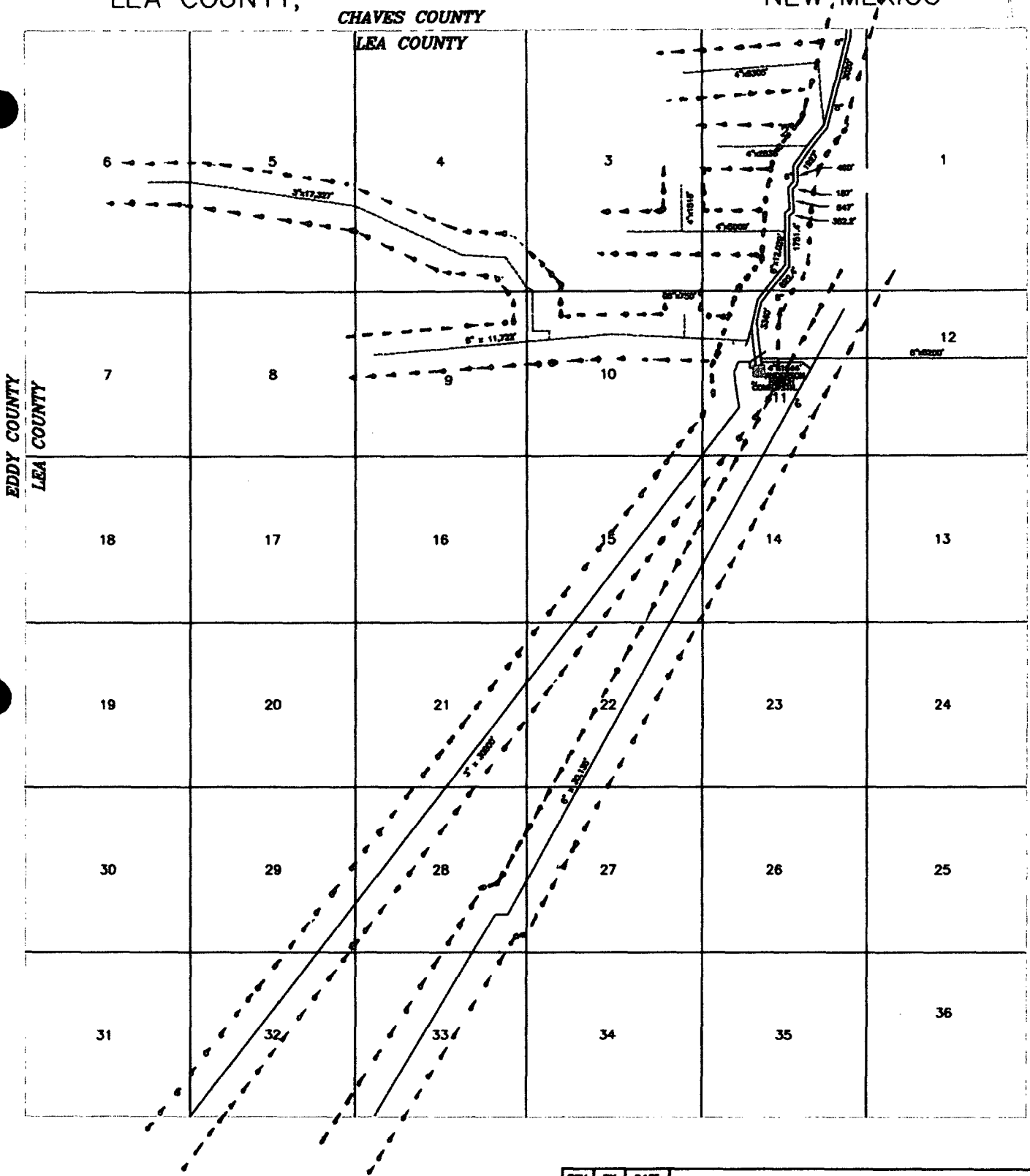
TOWNSHIP 16 SOUTH , RANGE 31 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_16-31

TOWNSHIP 16 SOUTH , RANGE 32 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	06-03-05

Frontier Field Services, LLC

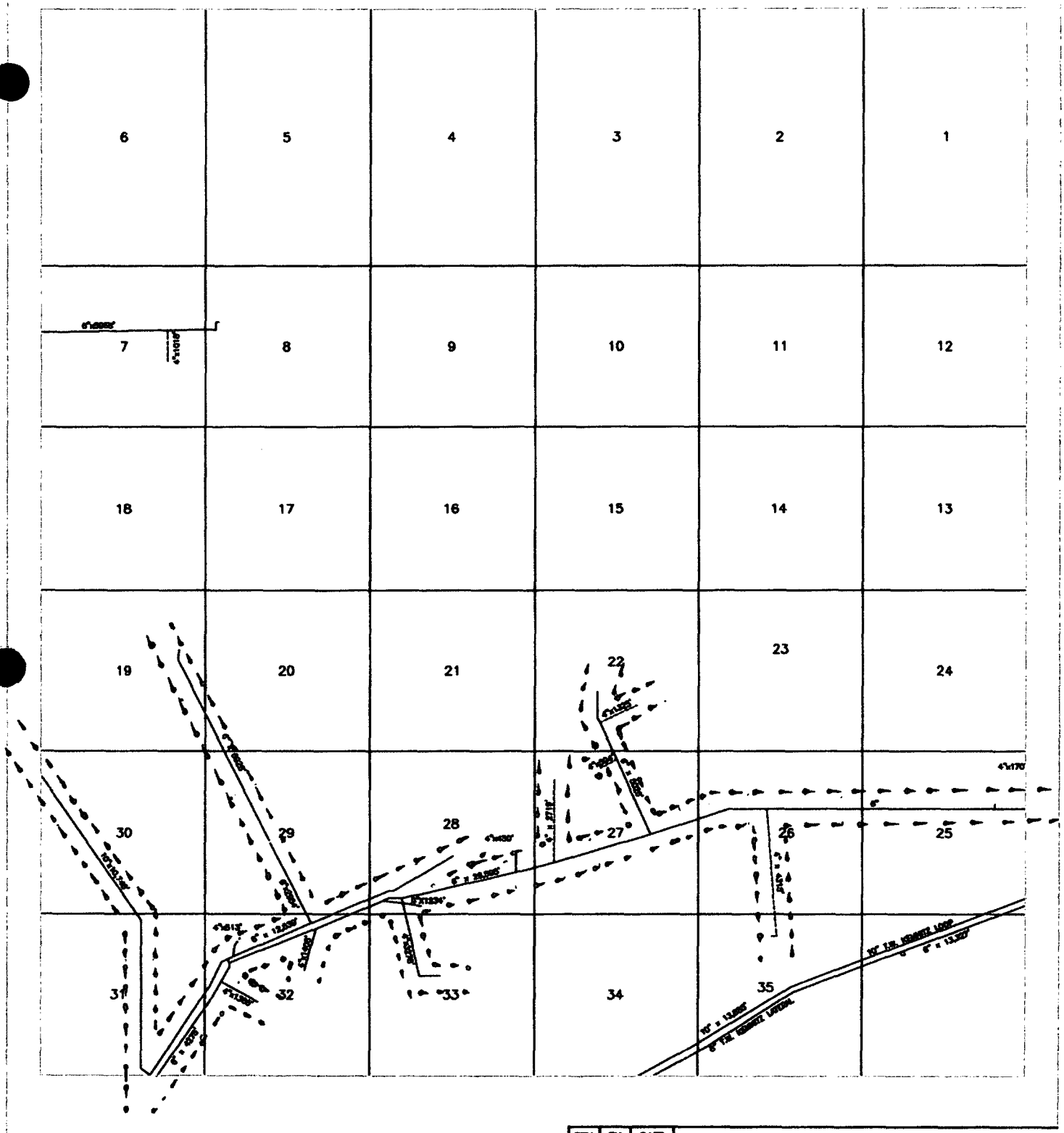
TOWNSHIP 16 SOUTH , RANGE 32 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_16-32

TOWNSHIP 16 SOUTH , RANGE 33 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	05-09-03

Frontier Field Services, LLC

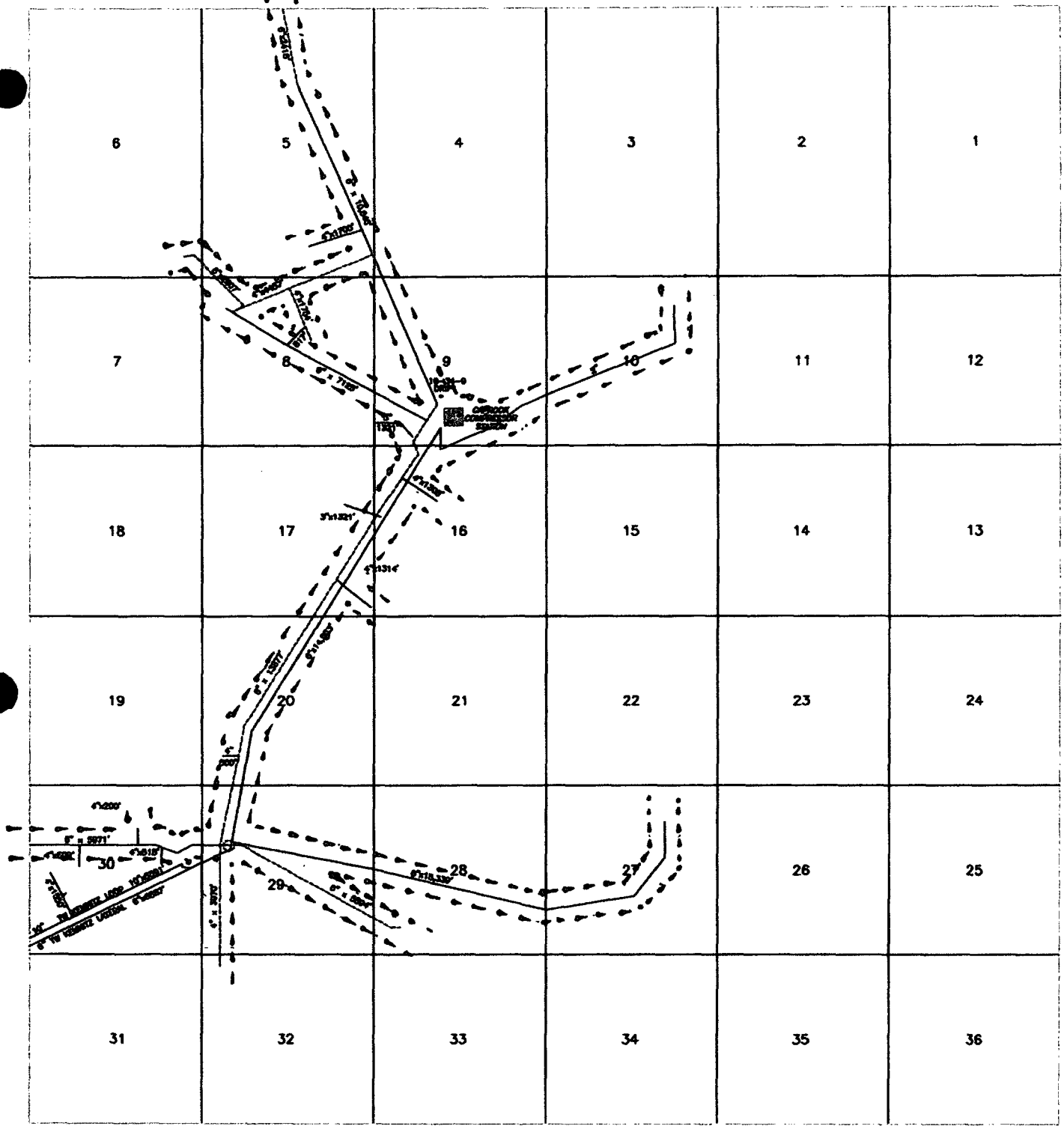
TOWNSHIP 16 SOUTH , RANGE 33 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_16-33

TOWNSHIP 16 SOUTH , RANGE 34 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

- POLY LINE
- STEEL LINE
- ROE BOUNDARY

REV.	BY	DATE
1	RLS	06-02-03

Frontier Field Services, LLC

TOWNSHIP 16 SOUTH , RANGE 34 EAST
NMPM , LEA COUNTY , NEW MEXICO

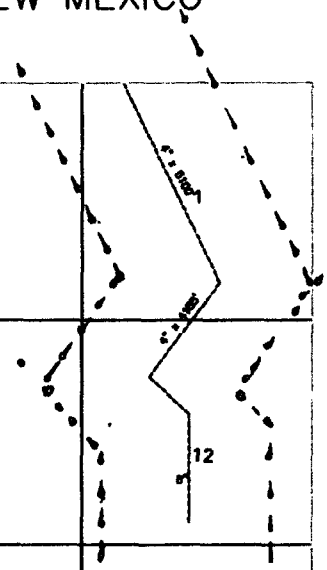
MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number: Mj_16-34

TOWNSHIP 17 SOUTH , RANGE 29 EAST , NMPM
EDDY COUNTY, NEW MEXICO

6	5	4	3	2	
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	26-03-03

Frontier Field Services, LLC

TOWNSHIP 17 SOUTH , RANGE 29 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_17-29

TOWNSHIP 17 SOUTH , RANGE 30 EAST , NMPM
EDDY COUNTY, NEW MEXICO

LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	05-02-03

Frontier Field Services, LLC

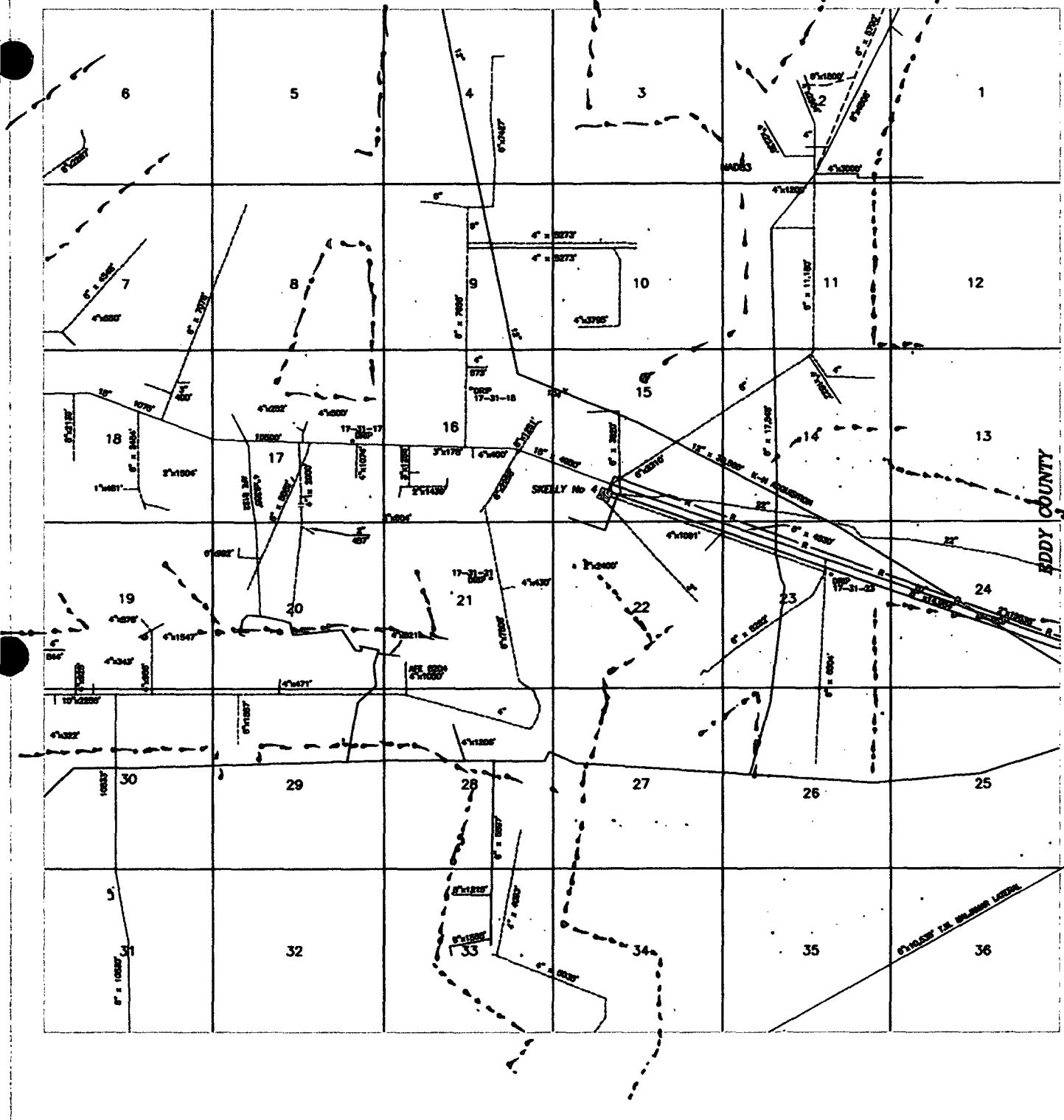
TOWNSHIP 17 SOUTH , RANGE 30 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_17-30

TOWNSHIP 17 SOUTH , RANGE 31 EAST , NMPM
EDDY COUNTY, NEW MEXICO



LINE LEGEND

- POLY LINE
- STEEL LINE
- ROE BOUNDARY

REV.	BY	DATE
1	RLS	06-02-03

Frontier
Field Services, LLC

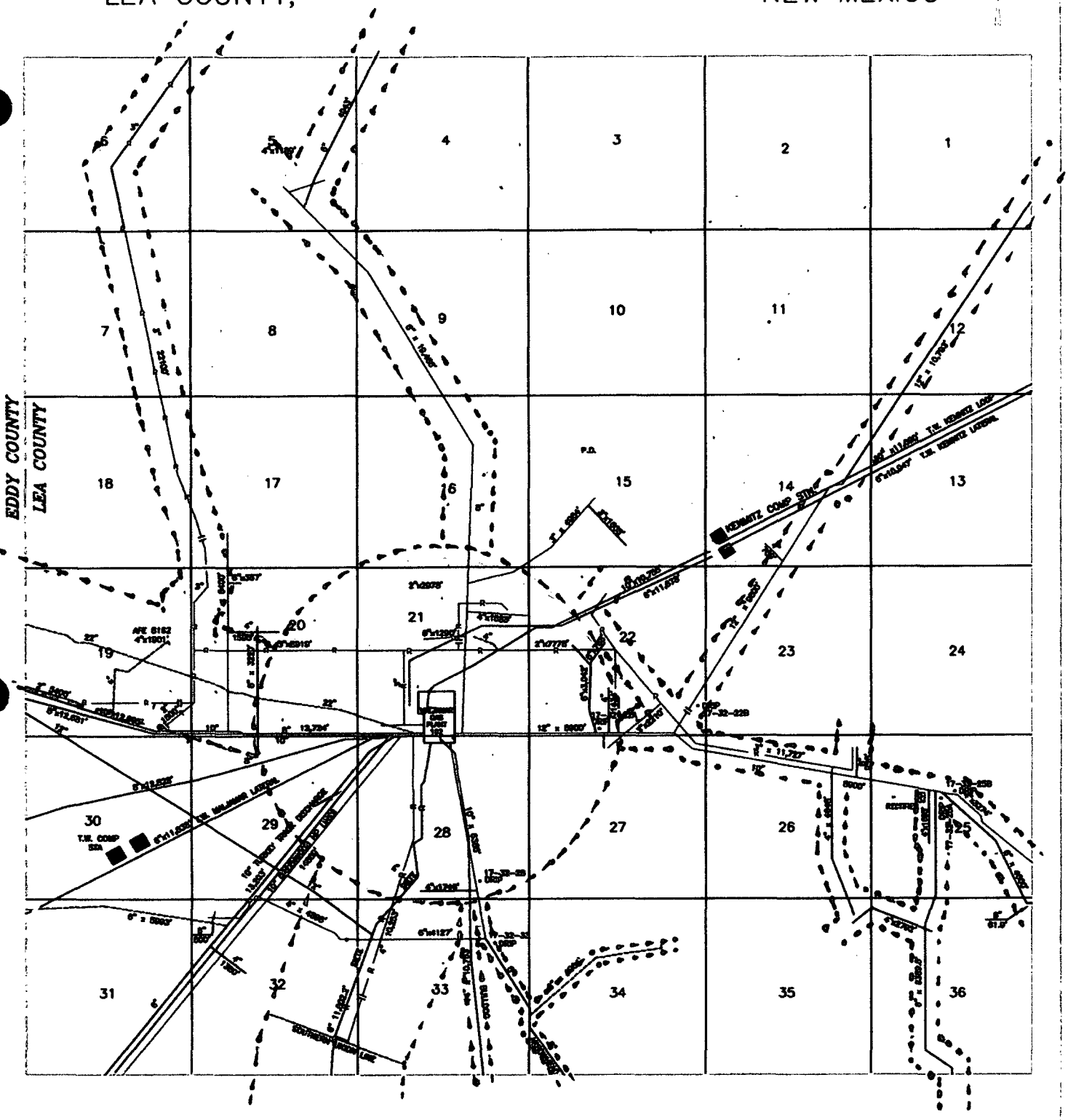
TOWNSHIP 17 SOUTH , RANGE 31 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_17-31

TOWNSHIP 17 SOUTH , RANGE 32 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

- POLY LINE
- STEEL LINE
- ROE BOUNDARY

REV.	BY	DATE
1	RLS	09-02-09

Frontier Field Services, LLC

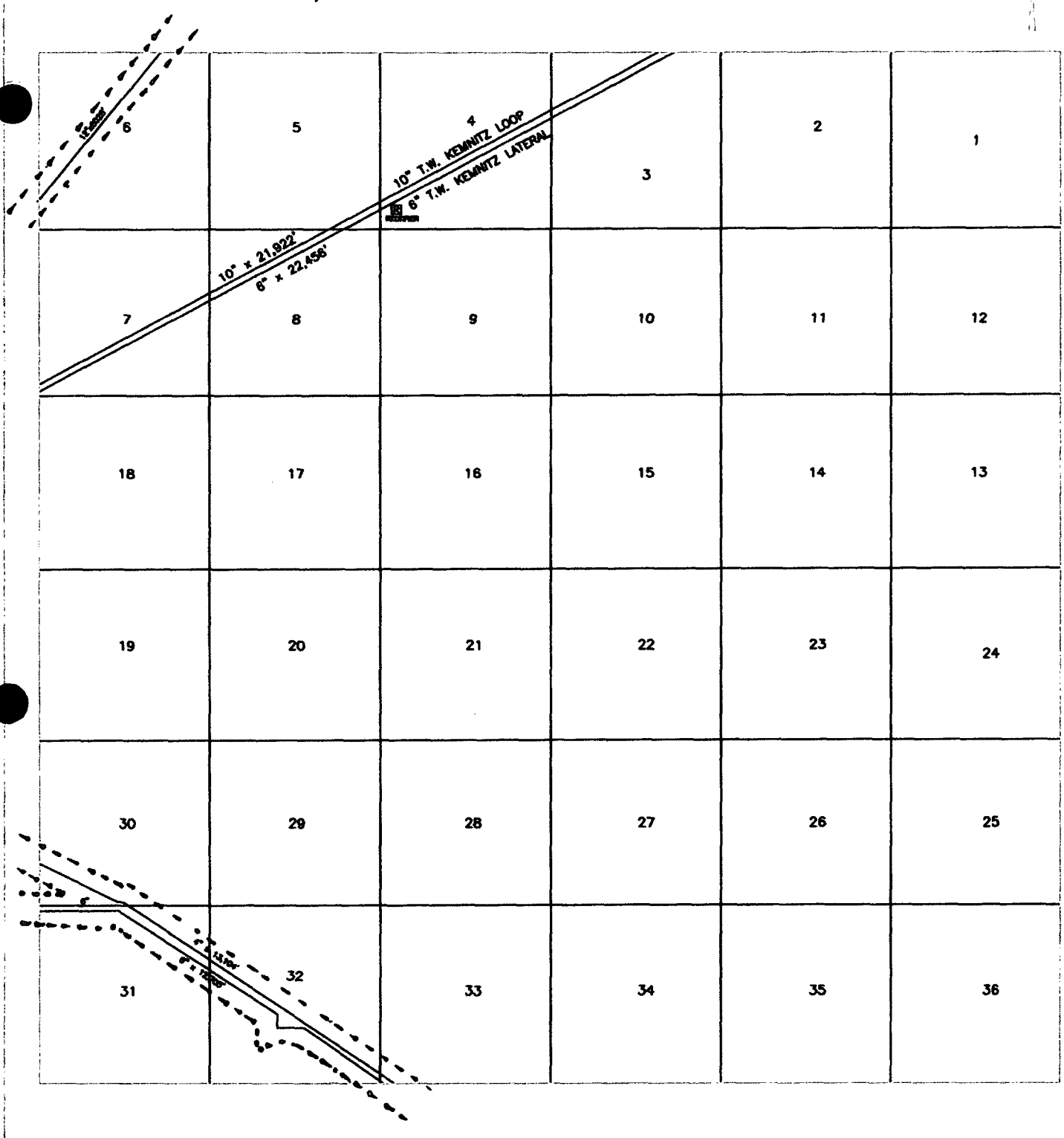
TOWNSHIP 17 SOUTH , RANGE 32 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number: MJ_17-32

TOWNSHIP 17 SOUTH , RANGE 33 EAST , NMPM
LEA COUNTY, NEW MEXICO



USER LEGEND

POLY LINE	
STEEL LINE	
ROE BOUNDARY	

REV.	BY	DATE
1	RLS	09-02-03

Frontier Field Services, LLC

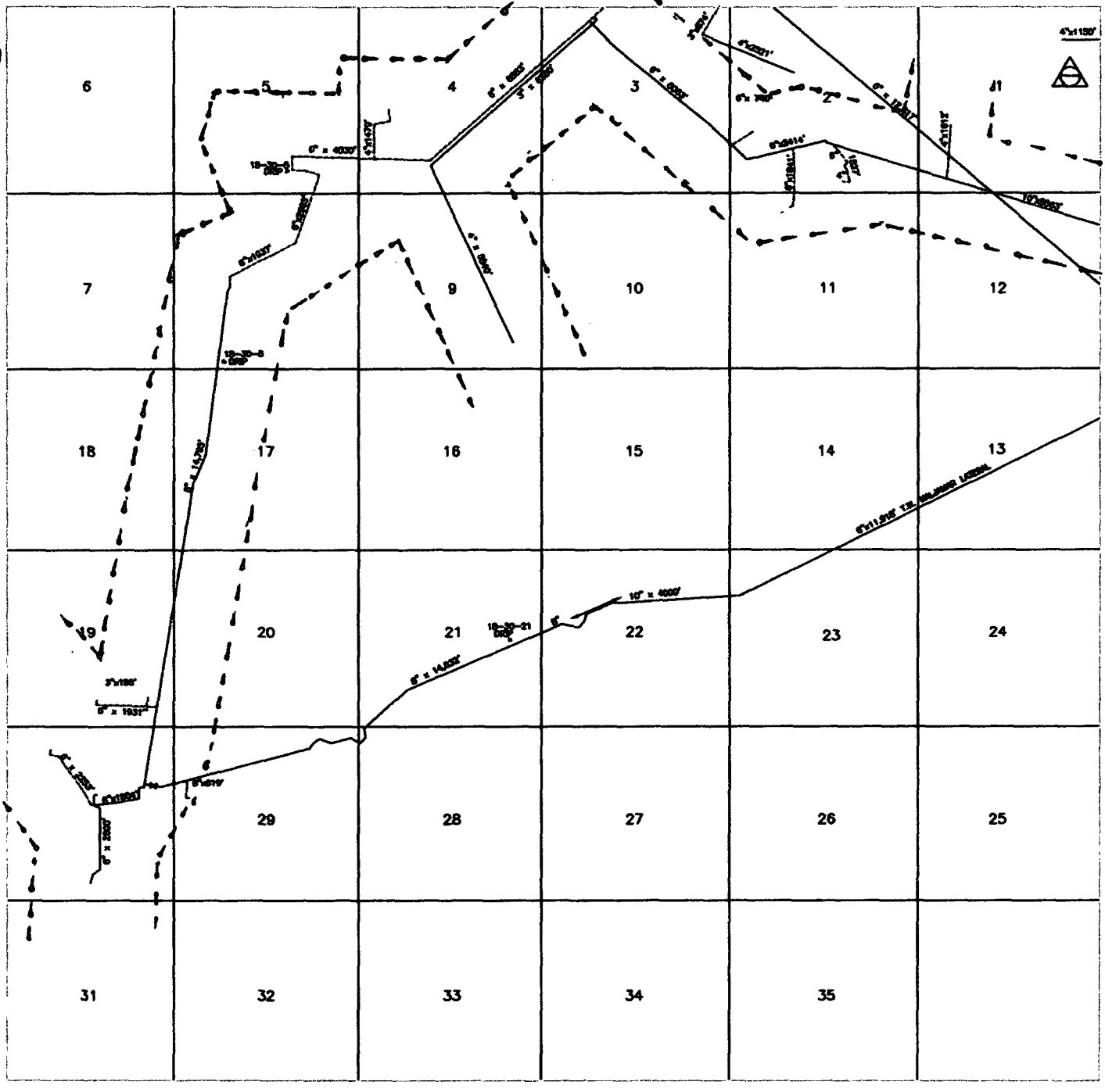
TOWNSHIP 17 SOUTH , RANGE 33 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number MJ_17-33

TOWNSHIP 18 SOUTH , RANGE 30 EAST , NMPM
EDDY COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE	
STEEL LINE	
ROE BOUNDARY	

REV.	BY	DATE
1	RLS	09-02-03

Frontier Field Services, LLC

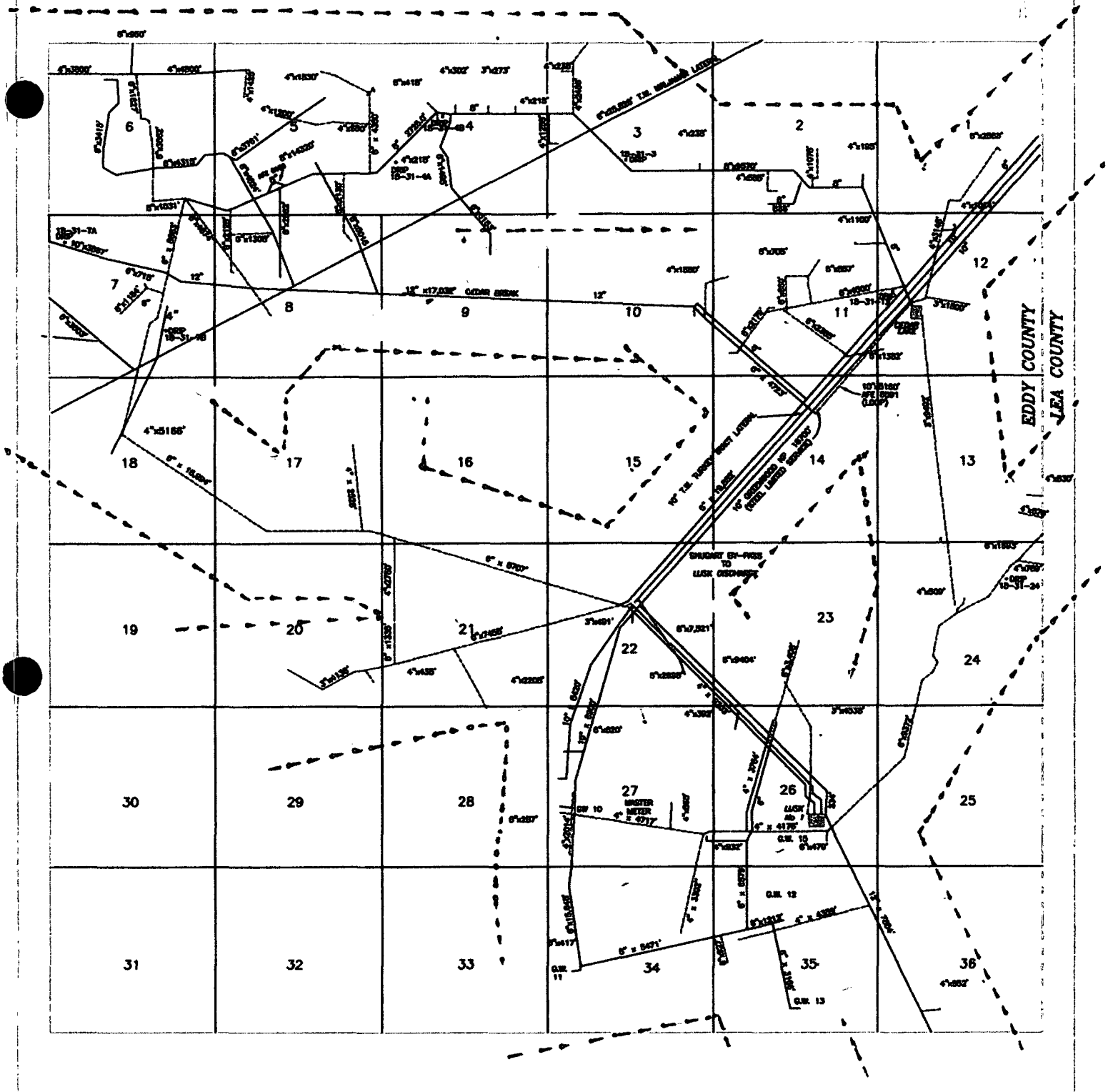
TOWNSHIP 18 SOUTH , RANGE 30 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number: MJ_18-30

TOWNSHIP 18 SOUTH , RANGE 31 EAST , NMPM
EDDY COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	05-03-05

Frontier Field Services, LLC

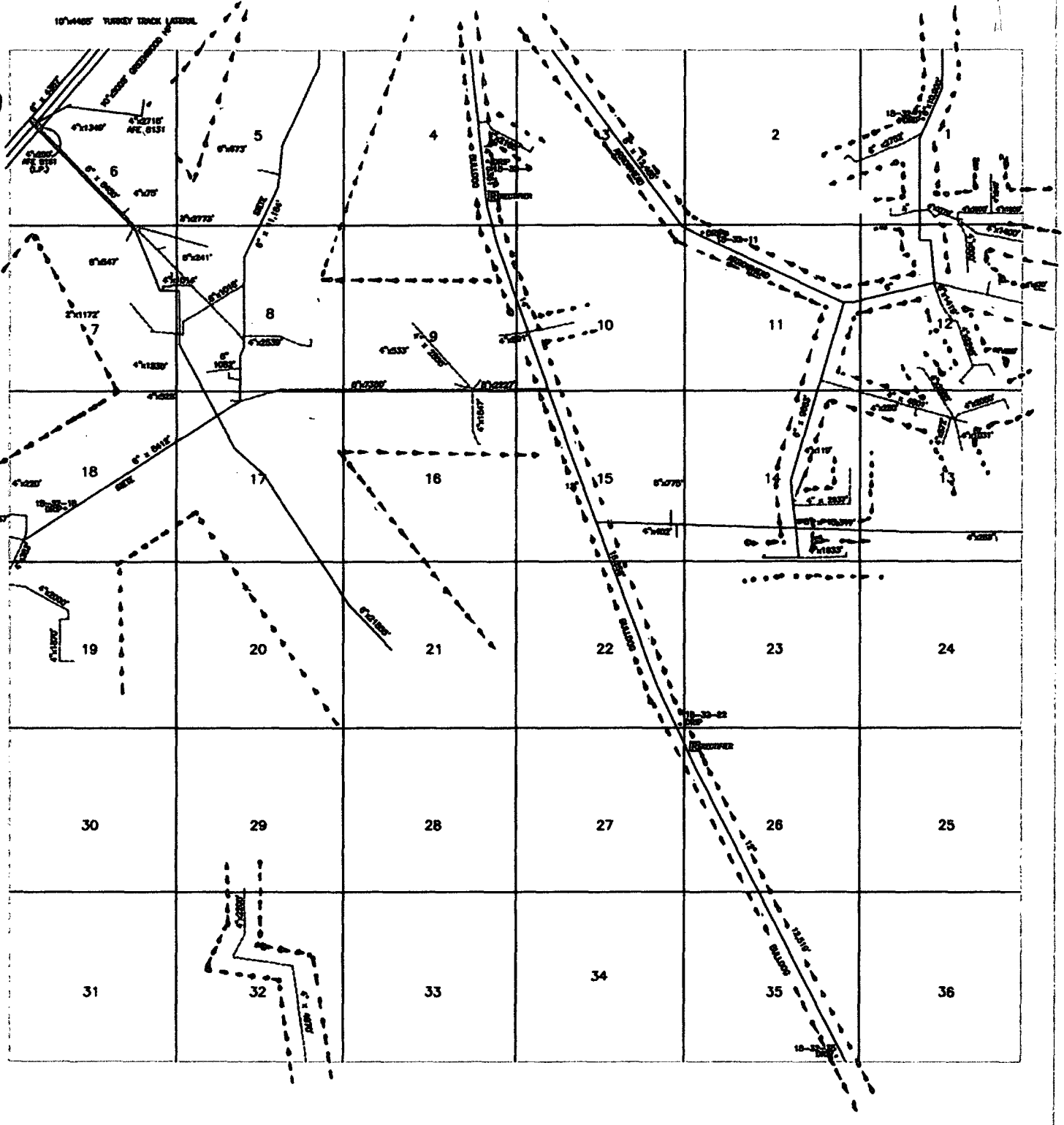
TOWNSHIP 18 SOUTH , RANGE 31 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_18-31

TOWNSHIP 18 SOUTH , RANGE 32 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	05-02-03

Frontier
Field Services, LLC

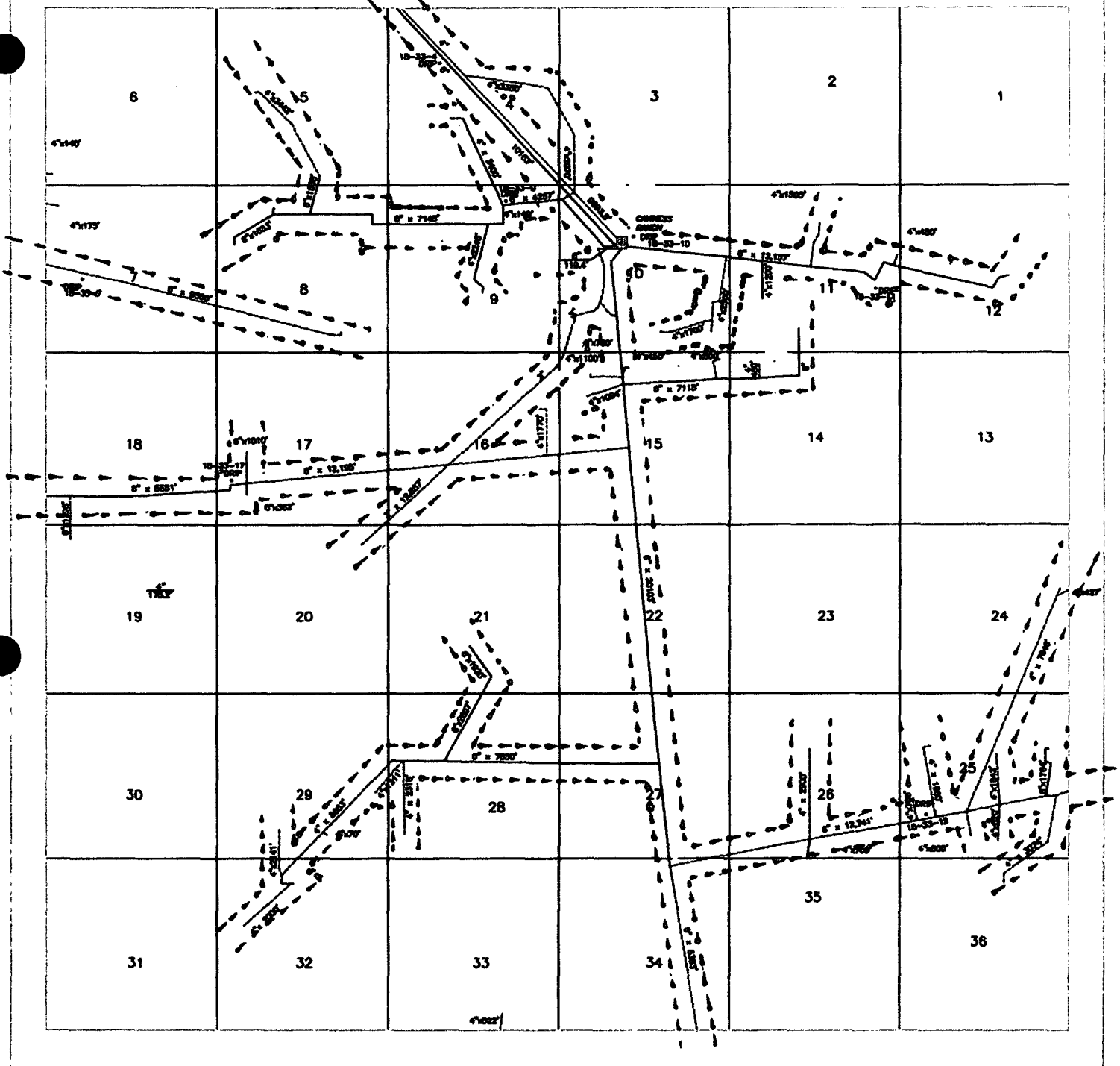
TOWNSHIP 18 SOUTH , RANGE 32 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_18-32

TOWNSHIP 18 SOUTH , RANGE 33 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLB	05-03-03

Frontier Field Services, LLC

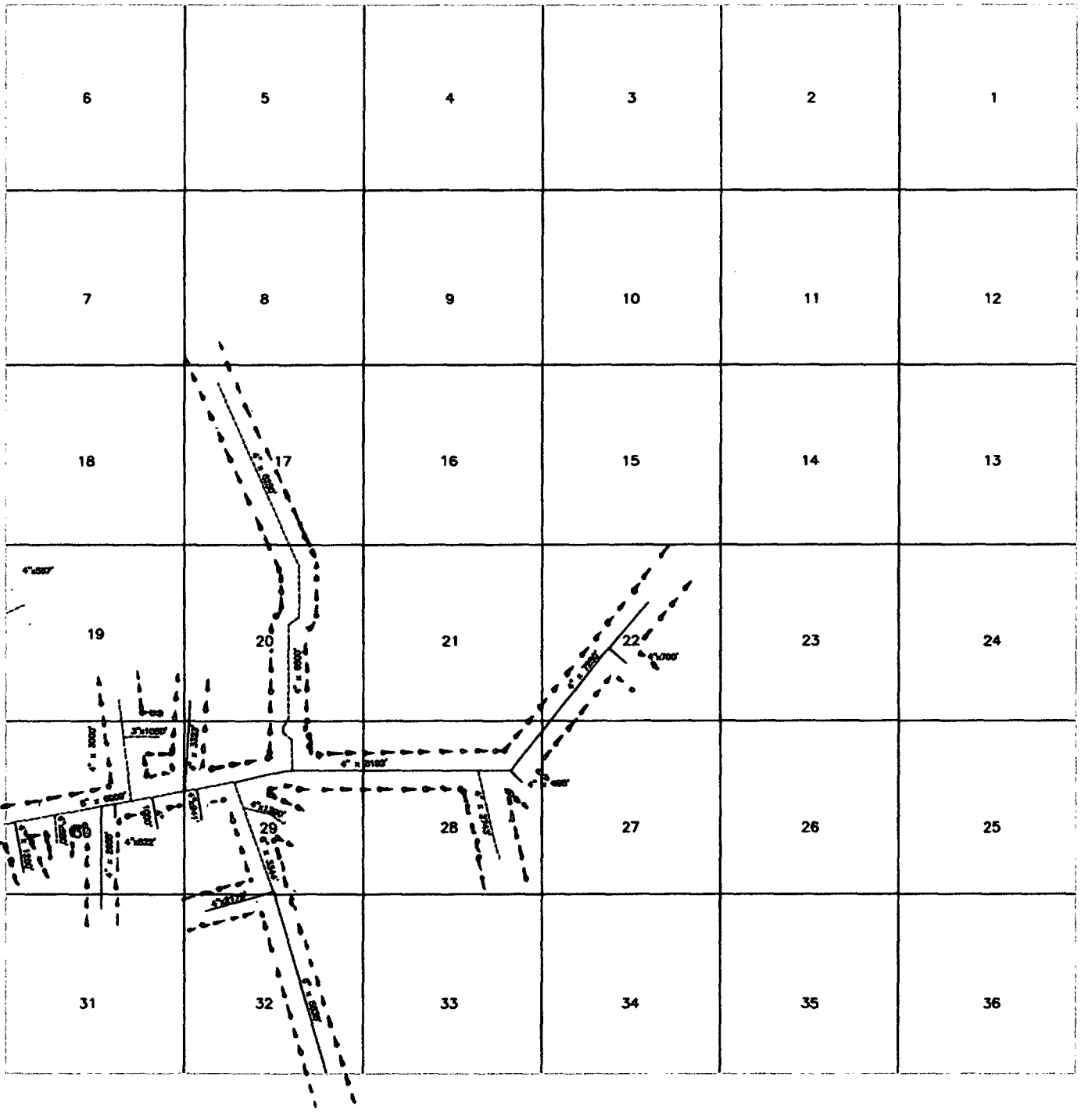
TOWNSHIP 18 SOUTH , RANGE 33 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number MJ_18-33

TOWNSHIP 18 SOUTH , RANGE 34 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLS	00-02-03

Frontier Field Services, LLC

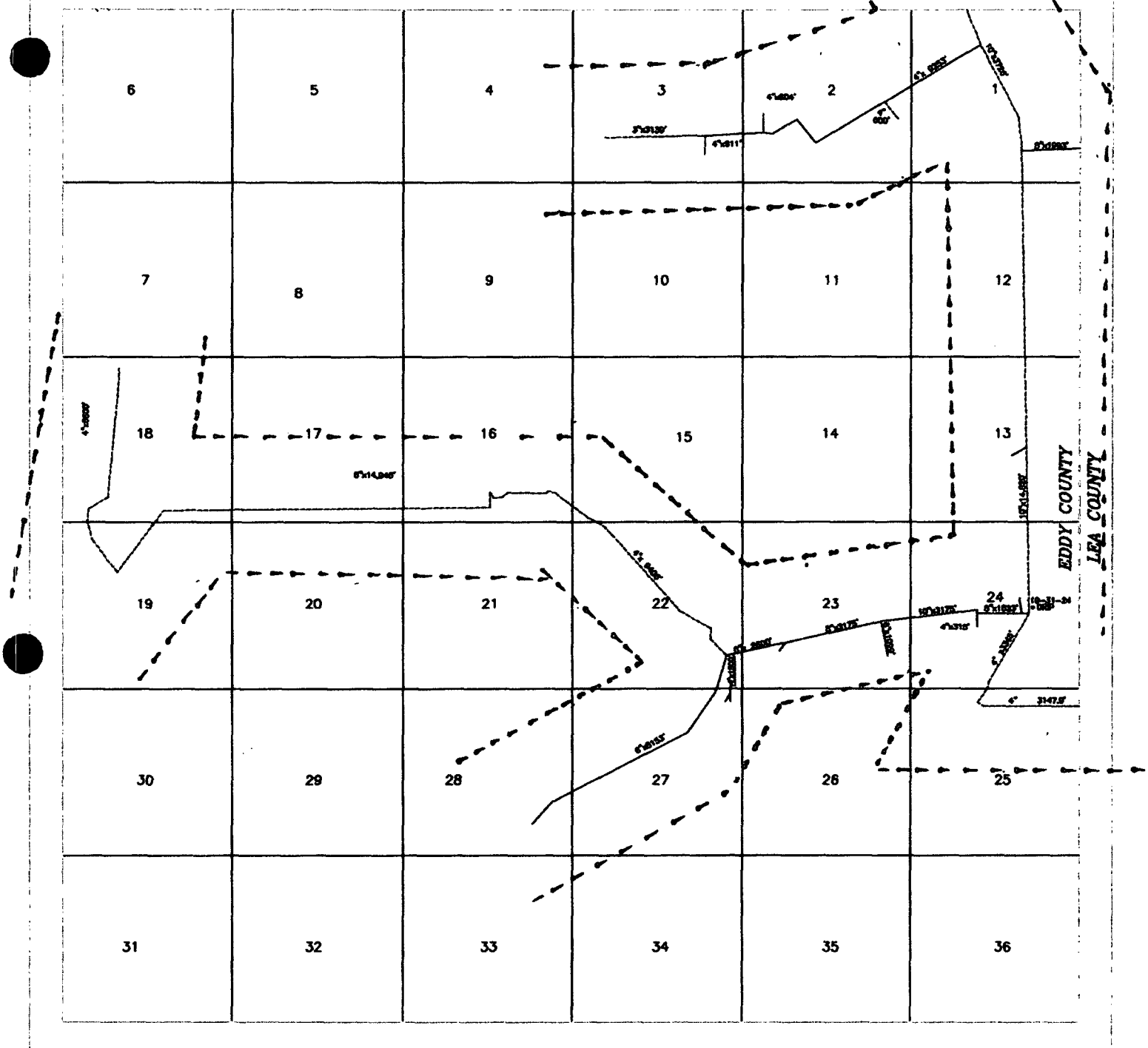
TOWNSHIP 18 SOUTH , RANGE 34 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_18-34

TOWNSHIP 19 SOUTH , RANGE 31 EAST , NMPM
EDDY COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLB	05-02-03

Frontier Field Services, LLC

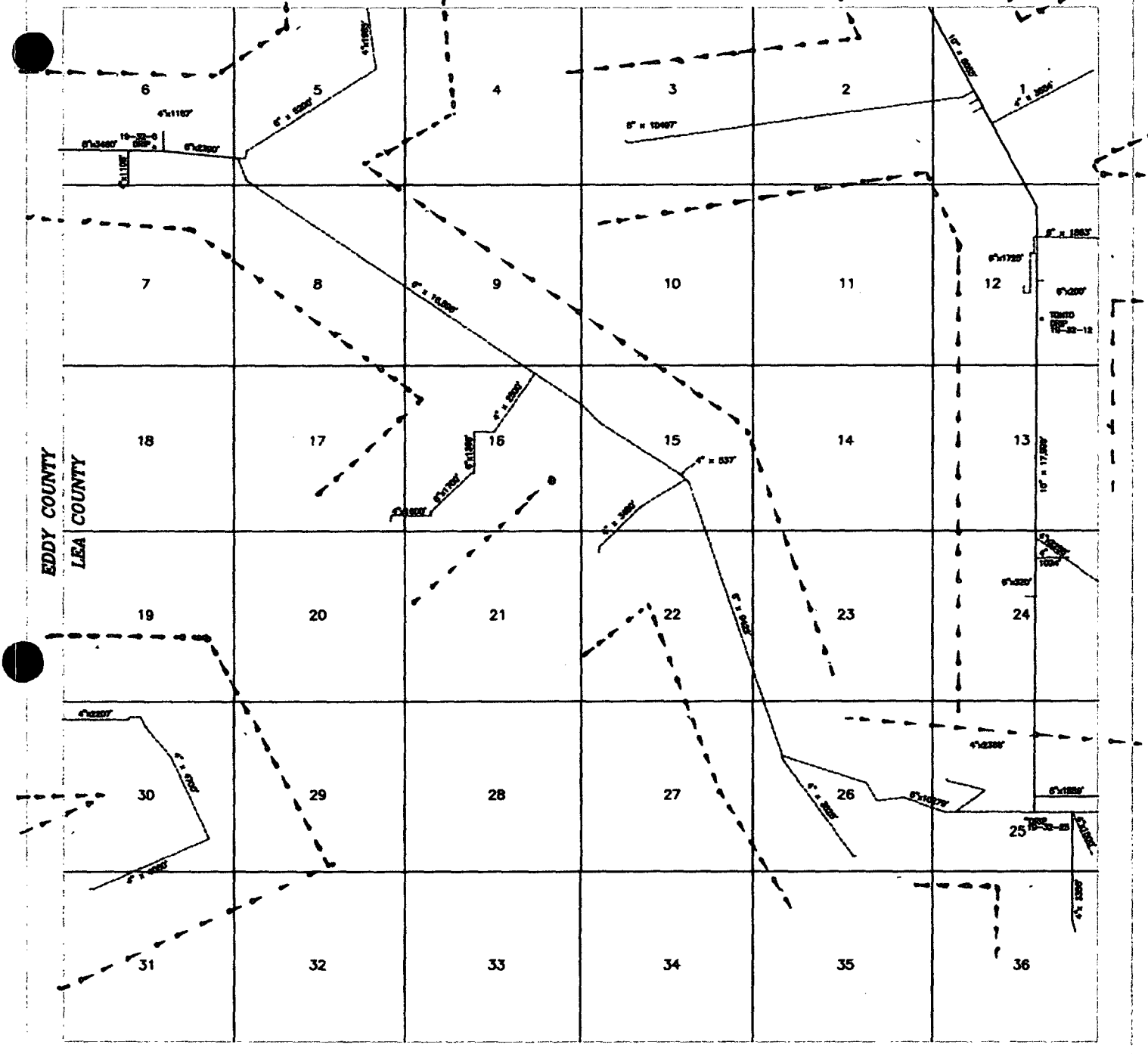
TOWNSHIP 19 SOUTH , RANGE 31 EAST
NMPM , EDDY COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
Mj_19-31

TOWNSHIP 19 SOUTH , RANGE 32 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

- POLY LINE
- STEEL LINE
- ROE BOUNDARY

REV.	BY	DATE
1	RLS	05-02-05

Frontier Field Services, LLC

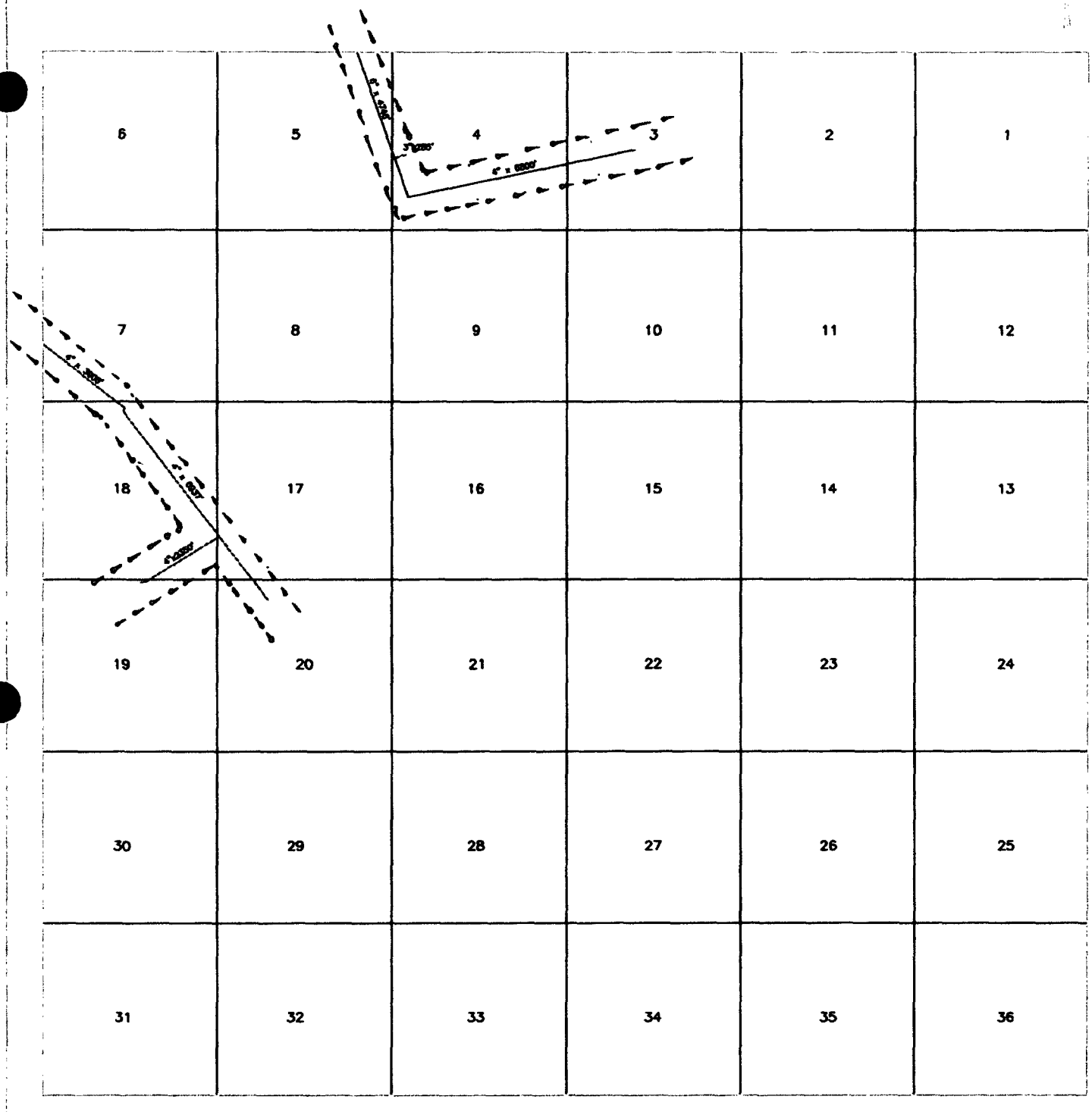
TOWNSHIP 19 SOUTH , RANGE 32 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_19-32

TOWNSHIP 19 SOUTH , RANGE 34 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	RLB	08-03-05

Frontier Field Services, LLC

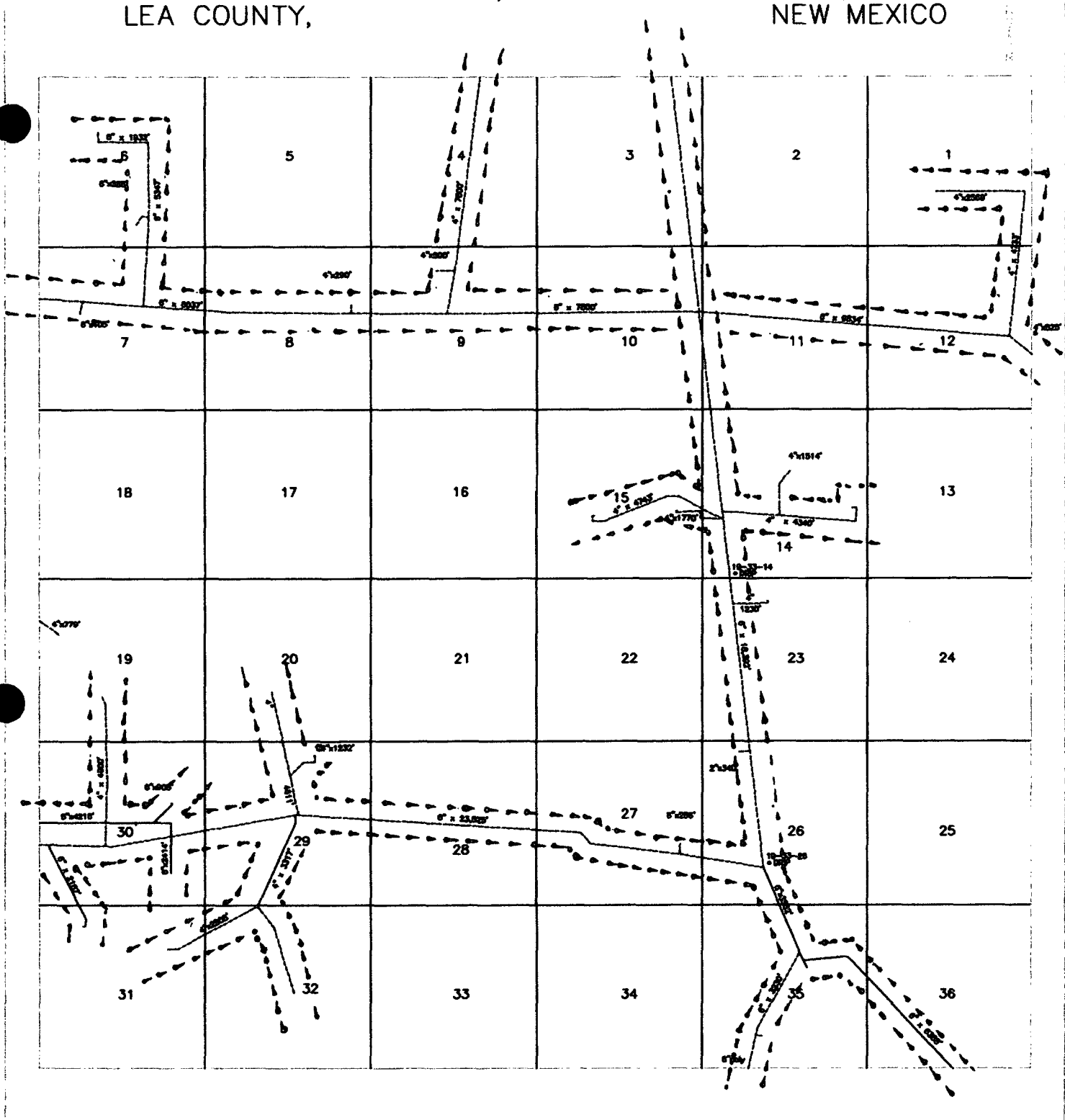
TOWNSHIP 19 SOUTH , RANGE 34 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number
MJ_19-34

TOWNSHIP 19 SOUTH , RANGE 33 EAST , NMPM
LEA COUNTY, NEW MEXICO



LINE LEGEND

POLY LINE

STEEL LINE

ROE BOUNDARY

REV.	BY	DATE
1	GLS	06-02-03

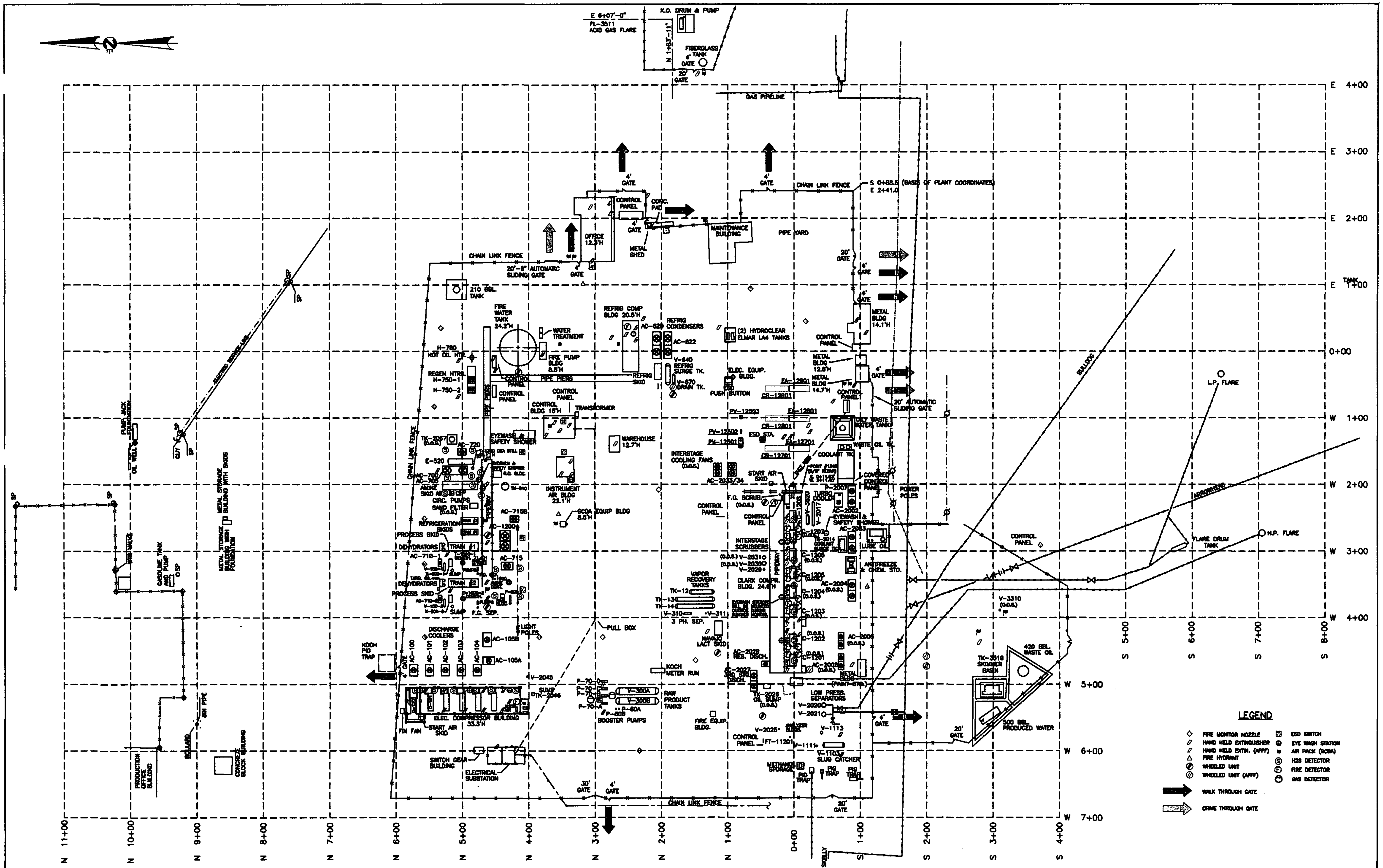
Frontier Field Services, LLC

TOWNSHIP 19 SOUTH , RANGE 33 EAST
NMPM , LEA COUNTY , NEW MEXICO

MALJAMAR GAS PLANT
GAS GATHERING SYSTEM MAP

SCALE : 1"=4690'

Drawing Number MJ_19-33



ISSUE	DATE	DRAWN	DESIGNED	CHECKED	APPROVED
3	REMOVED 500 BBL. SPENT AMINE TANK AND ADDED 210 BBL. TANK				
	5/16/02	MSR	MSR		
2	REVISED PER AS-BUILT FIELD NOTES				
	5/16/02	MSR	MSR		
1	REVISED PER INLET COMPRESSION PROJECT				
	10/08/01	Coff	JP		
0	ISSUE PLOT PLAN AS BUILT, REV. SAFETY EQUIP. PER PLANT COMMENTS				
	6/13/00	MSR	RRQ/MSR		
B	ADDED (3) VAPOR RECOVERY VESSELS & GAS DETECTORS				
	6/5/97	RGK	VAC		

AFE:

ConocoPhillips

MIDSTREAM OPERATIONS

MALJAMAR GAS PLANT

PLOT PLAN OF SAFETY SYSTEMS AND ESCAPE ROUTES

SCALE: 1"=80'

LOCATION: LEA COUNTY, NM

FILE NO: MJ20004

MJ-20004 REV NO 3

Frontier Field Services
Maljamar, NM System

Anderson Ranch Pipeline System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter **H2S** in **PPM**	10000	*enter Data in green shaded areas*	
Enter Gas flow in **mcf/day**	2300		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	10455.8	formula	
Mult factor for 300 ppm ROE	17710	formula	
Mult factor for 100 ppm ROE	36547	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	23	mcf/day	
H2S Concentration Volume Fraction	0.01	decimal equivalent	
H2S Concentration Volume Fraction in percent %	1.00%	percent	
500 ppm radius of exposure (public road)	**328**	feet	***ANSWER***
300 ppm radius of exposure	**456**	feet	***ANSWER***
100 ppm radius of exposure (public area)	**717**	feet	***ANSWER***

Conversions:

To convert H2S in percent to parts per million (ppm) Put H2S in % in blue shaded area, read answer to the right in the yellow shaded area in ppm	Input H2S in % below 1	ppm 10000	***ANSWER***
To convert H2S from parts per million (ppm) to percent Put H2S in ppm in blue shaded area, read answer to the right in the yellow shaded area in percent	Input H2S in ppm below 10000	% 1.0000%	***ANSWER***
To convert gas flow in cubic feet per day to mcf per day put cubic feet per day in blue shaded area, read answer to the right in the yellow shaded area in MCF	Input cubic feet per day below 2300000	mcf/day 2300	***ANSWER***
To convert gas flow from MCF per day to cubic feet per day put MCF per day in blue shaded area, read answer to the right in the yellow shaded area in Cubic feet per day	Input MCF day below 2300	Cubic feet per day 2300000	***ANSWER***

Frontier Field Services
Maljamar, NM System

Arrowhead Pipeline System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter H2S in PPM	[redacted]	*enter Data in green shaded areas*	
	500		
Enter Gas flow in mcf/day	[redacted]		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	13582.54	formula	
Mult factor for 300 ppm ROE	23023	formula	
Mult factor for 100 ppm ROE	47511.1	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	29.9	mcf/day	
H2S Concentration Volume Fraction	0.013	decimal equivalent	
H2S Concentration Volume Fraction in percent %	1.30%	percent	
500 ppm radius of exposure (public road)	**388**	feet	*ANSWER*
300 ppm radius of exposure	**537**	feet	*ANSWER*
100 ppm radius of exposure (public area)	**845**	feet	*ANSWER*

Conversions:

To convert H2S in percent to parts per million (ppm) Put H2S in % in blue shaded area, read answer to the right in the yellow shaded area in ppm	Input H2S in % below 1.3	ppm 13000	*ANSWER*
To convert H2S from parts per million (ppm) to percent Put H2S in ppm in blue shaded area, read answer to the right in the yellow shaded area in percent	Input H2S in ppm below 13000	% 1.3000%	*ANSWER*
To convert gas flow in cubic feet per day to mcf per day put cubic feet per day in blue shaded area; read answer to the right in the yellow shaded area in MCF	Input cubic feet per day below 600000	mcf/day 600	*ANSWER*
To convert gas flow from MCF per day to cubic feet per day put MCF per day in blue shaded area; read answer to the right in the yellow shaded area in Cubic feet per day	Input MCF day below 600	Cubic feet per day 600000	*ANSWER*

Frontier Field Services
Maljamar, NM System

Bulldog Pipeline System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter H2S in PPM	1000	*enter Data in green shaded areas*	
Enter Gas flow in mcf/day	2700		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	1227.42	formula	
Mult factor for 300 ppm ROE	2079	formula	
Mult factor for 100 ppm ROE	4290.3	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	2.7	mcf/day	
H2S Concentration Volume Fraction	0.001	decimal equivalent	
H2S Concentration Volume Fraction in percent %	0.10%	percent	
500 ppm radius of exposure (public road)	**86**	feet	*ANSWER*
300 ppm radius of exposure	**119**	feet	*ANSWER*
100 ppm radius of exposure (public area)	**188**	feet	*ANSWER*

Conversions:

To convert H2S in percent to parts per million (ppm)
Put H2S in % in blue shaded area; read answer to the right in the yellow shaded area in ppm

Input H2S in % below	ppm	
0.1	1000	*ANSWER*

To convert H2S from parts per million (ppm) to perecent
Put H2S in ppm in blue shaded area; read answer to the right in the yellow shaded area in percent

Input H2S in ppm below	%	
1000	0.1000%	*ANSWER*

To convert gas flow in cubic feet per day to mcf per day
put cubic feet per day in blue shaded area; read answer to the right in the yellow shaded area in MCF

Input cubic feet per day below	mcf/day	
2700000	2700	*ANSWER*

To convert gas flow from MCF per day to cubic feet per day
put MCF per day in blue shaded area; read answer to the right in the yellow shaded area in Cubic feet per day

Input MCF day below	Cubic feet per day	
2700	2700000	*ANSWER*

Frontier Field Services
Maljamar, NM System

Caprock Pipeline System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter H2S in PPM	[redacted]	*enter Data in green shaded areas*	
Enter Gas flow in mcf/day	[redacted]		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	5455.2	formula	
Mult factor for 300 ppm ROE	9240	formula	
Mult factor for 100 ppm ROE	19068	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	12	mcf/day	
H2S Concentration Volume Fraction	0.01	decimal equivalent	
H2S Concentration Volume Fraction in percent %	1.00%	percent	
500 ppm radius of exposure (public road)	**218**	feet	*ANSWER*
300 ppm radius of exposure	**303**	feet	*ANSWER*
100 ppm radius of exposure (public area)	**477**	feet	*ANSWER*

Conversions:

To convert H2S in percent to parts per million (ppm)
Put H2S in % in blue shaded area; read answer to the right in the yellow shaded area in ppm

Input H2S in % below	ppm	
1	10000	*ANSWER*

To convert H2S from parts per million (ppm) to perecent
Put H2S in ppm in blue shaded area; read answer to the right in the yellow shaded area in percent

Input H2S in ppm below	%	
10000	1.0000%	*ANSWER*

To convert gas flow in cubic feet per day to mcf per day
put cubic feet per day in blue shaded area, read answer to the right in the yellow shaded area in MCF

Input cubic feet per day below	mcf/day	
1200000	1200	*ANSWER*

To convert gas flow from MCF per day to cubic feet per day
put MCF per day in blue shaded area; read answer to the right in the yellow shaded area in Cubic feet per day

Input MCF day below	Cubic feet per day	
1200	1200000	*ANSWER*

Frontier Field Services
Maljamar, NM System

Caviness Ranch Pipeline System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter H2S in PPM	[redacted]	*enter Data in green shaded areas*	
Enter Gas flow in mcf/day	[redacted]		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	5455.2	formula	
Mult factor for 300 ppm ROE	9240	formula	
Mult factor for 100 ppm ROE	19068	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	12	mcf/day	
H2S Concentration Volume Fraction	0.004	decimal equivalent	
H2S Concentration Volume Fraction in percent %	0.40%	percent	
500 ppm radius of exposure (public road)	**218**	feet	***ANSWER***
300 ppm radius of exposure	**303**	feet	***ANSWER***
100 ppm radius of exposure (public area)	**477**	feet	***ANSWER***

Conversions:

To convert H2S in percent to parts per million (ppm)
Put H2S in % in blue shaded area; read answer to the right in the yellow shaded area in ppm

Input H2S in % below	ppm	
0.4	4000	***ANSWER***

To convert H2S from parts per million (ppm) to perecent
Put H2S in ppm in blue shaded area; read answer to the right in the yellow shaded area in percent

Input H2S in ppm below	%	
4000	0.4000%	***ANSWER***

To convert gas flow in cubic feet per day to mcf per day
put cubic feet per day in blue shaded area; read answer to the right in the yellow shaded area in MCF

Input cubic feet per day below	mcf/day	
3000000	3000	***ANSWER***

To convert gas flow from MCF per day to cubic feet per day
put MCF per day in blue shaded area; read answer to the right in the yellow shaded area in Cubic feet per day

Input MCF day below	Cubic feet per day	
3000	3000000	***ANSWER***

Frontier Field Services
Maljamar, NM System

Cedar Lake/Lusk Pipeline System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter H2S in PPM	20000	*enter Data in green shaded areas*	
Enter Gas flow in mcf/day	8300		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	75463.6	formula	
Mult factor for 300 ppm ROE	127820	formula	
Mult factor for 100 ppm ROE	263774	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	166	mcf/day	
H2S Concentration Volume Fraction	0.02	decimal equivalent	
H2S Concentration Volume Fraction in percent %	2.00%	percent	
500 ppm radius of exposure (public road)	**1128**	feet	*ANSWER*
300 ppm radius of exposure	**1569**	feet	*ANSWER*
100 ppm radius of exposure (public area)	**2469**	feet	*ANSWER*

Conversions:

To convert H2S in percent to parts per million (ppm)
Put H2S in % in blue shaded area; read answer to the right in the yellow shaded area in ppm

Input H2S in % below	ppm	
2	20000	*ANSWER*

To convert H2S from parts per million (ppm) to perecent
Put H2S in ppm in blue shaded area; read answer to the right in the yellow shaded area in percent

Input H2S in ppm below	%	
20000	2.0000%	*ANSWER*

To convert gas flow in cubic feet per day to mcf per day
put cubic feet per day in blue shaded area; read answer to the right in the yellow shaded area in MCF

Input cubic feet per day below	mcf/day	
8300000	8300	*ANSWER*

To convert gas flow from MCF per day to cubic feet per day
put MCF per day in blue shaded area; read answer to the right in the yellow shaded area in Cubic feet per day

Input MCF day below	Cubic feet per day	
8300	8300000	*ANSWER*

Frontier Field Services
Maljamar, NM System

Maljamar Plant System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter H2S in PPM	12000	*enter Data in green shaded areas*	
Enter Gas flow in mcf/day	26000		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	141836.2	formula	
Mult factor for 300 ppm ROE	240240	formula	
Mult factor for 100 ppm ROE	495768	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	312	mcf/day	
H2S Concentration Volume Fraction	0.012	decimal equivalent	
H2S Concentration Volume Fraction in percent %	1.20%	percent	
500 ppm radius of exposure (public road)	**1675**	feet	*ANSWER*
300 ppm radius of exposure	**2329**	feet	*ANSWER*
100 ppm radius of exposure (public area)	**3665**	feet	*ANSWER*

Conversions:

To convert H2S in percent to parts per million (ppm)
Put H2S in % in blue shaded area; read answer to the right in the yellow shaded area in ppm

Input H2S in % below	ppm	
1.2	12000	*ANSWER*

To convert H2S from parts per million (ppm) to perecent
Put H2S in ppm in blue shaded area; read answer to the right in the yellow shaded area in percent

Input H2S in ppm below	%	
12000	1.2000%	*ANSWER*

To convert gas flow in cubic feet per day to mcf per day
put cubic feet per day in blue shaded area; read answer to the right in the yellow shaded area in MCF

Input cubic feet per day below	mcf/day	
26000000	26000	*ANSWER*

To convert gas flow from MCF per day to cubic feet per day
put MCF per day in blue shaded area; read answer to the right in the yellow shaded area in Cubic feet per day

Input MCF day below	Cubic feet per day	
26000	26000000	*ANSWER*

Frontier Field Services
Maljamar, NM System

Skelly Pipeline System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter H2S in PPM	[redacted]	*enter Data in green shaded areas*	
Enter Gas flow in mcf/day	[redacted]		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	53188.2	formula	
Mult factor for 300 ppm ROE	90090	formula	
Mult factor for 100 ppm ROE	185913	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	117	mcf/day	
H2S Concentration Volume Fraction	0.013	decimal equivalent	
H2S Concentration Volume Fraction in percent %	1.30%	percent	
500 ppm radius of exposure (public road)	**907**	feet	***ANSWER***
300 ppm radius of exposure	**1261**	feet	***ANSWER***
100 ppm radius of exposure (public area)	**1984**	feet	***ANSWER***

Conversions:

To convert H2S in percent to parts per million (ppm)
Put H2S in % in blue shaded area, read answer to the right in the yellow shaded area in ppm

Input H2S in % below	ppm	
1.3	13000	***ANSWER***

To convert H2S from parts per million (ppm) to perecent
Put H2S in ppm in blue shaded area, read answer to the right in the yellow shaded area in percent

Input H2S in ppm below	%	
13000	1.3000%	***ANSWER***

To convert gas flow in cubic feet per day to mcf per day
put cubic feet per day in blue shaded area; read answer to the right in the yellow shaded area in MCF

Input cubic feet per day below	mcf/day	
9000000	9000	***ANSWER***

To convert gas flow from MCF per day to cubic feet per day
put MCF per day in blue shaded area; read answer to the right in the yellow shaded area in Cubic feet per day

Input MCF day below	Cubic feet per day	
9000	9000000	***ANSWER***

Frontier Field Services
Maljamar, NM System

Skelly Pipeline System Calculations

OCD Rule 118

Pasquill-Gifford Equation for Calculating Radius of Exposure (ROE) of Hydrogen Sulfide (H2S)

Enter H2S in PPM	13000	*enter Data in green shaded areas*	
Enter Gas flow in mcf/day	9000		
Constant for 500 ppm ROE	0.4546	constant	
Constant for 300 ppm ROE	0.77	constant	
Constant for 100 ppm ROE	1.589	constant	
Mult factor for 500 ppm ROE	53188.2	formula	
Mult factor for 300 ppm ROE	90090	formula	
Mult factor for 100 ppm ROE	185913	formula	
Flow Rate of Pure H2S in Gas Stream (Actual Volume Fraction)	117	mcf/day	
H2S Concentration Volume Fraction	0.013	decimal equivalent	
H2S Concentration Volume Fraction in percent %	1.30%	percent	
500 ppm radius of exposure (public road)	**907**	feet	*ANSWER*
300 ppm radius of exposure	**1261**	feet	*ANSWER*
100 ppm radius of exposure (public area)	**1984**	feet	*ANSWER*

Conversions:

To convert H2S in percent to parts per million (ppm)
Put H2S in % in blue shaded area; read answer to the right in the yellow shaded area in ppm

Input H2S in % below	ppm	
1.3	13000	*ANSWER*

To convert H2S from parts per million (ppm) to perecent
Put H2S in ppm in blue shaded area; read answer to the right in the yellow shaded area in percent

Input H2S in ppm below	%	
13000	1.3000%	*ANSWER*

To convert gas flow in cubic feet per day to mcf per day
put cubic feet per day in blue shaded area; read answer to the right in the yellow shaded area in MCF

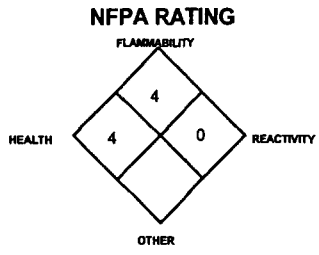
Input cubic feet per day below	mcf/day	
9000000	9000	*ANSWER*

To convert gas flow from MCF per day to cubic feet per day
put MCF per day in blue shaded area; read answer to the right in the yellow shaded area in Cubic feet per day

Input MCF day below	Cubic feet per day	
9000	9000000	*ANSWER*

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards



PART I *What is the material and what do I need to know in an emergency?*

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS:	**HYDROGEN SULFIDE - H_2S**
	Document Number: 001029
PRODUCT USE:	For general analytical/synthetic chemical uses.
SUPPLIER/MANUFACTURER'S NAME:	AIRGAS INC.
ADDRESS:	259 N. Radnor-Chester Road Suite 100 Radnor, PA 19087-5283
BUSINESS PHONE:	1-610-687-5253
EMERGENCY PHONE:	1-800-949-7937 International: 423-479-0293
DATE OF PREPARATION:	May 20, 1996
REVISION DATE:	February 3, 2001

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH		OSHA			
			TLV ppm	STEL ppm	PEL ppm	STEL ppm	IDLH ppm	OTHER
Hydrogen Sulfide	7783-06-4	> 99.0%	10	15	20 C 10 (Vacated 1989 PEL)	50 ppm (10 minute maximum peak) 15 (Vacated 1989 PEL)	100	NIOSH REL: 10 ppm C (10 minutes) DFG-MAK: 10 ppm
Maximum Impurities		< 1.0%	None of the trace impurities in this mixture contribute significantly to the hazards associated with the product. All hazard information pertinent to this product has been provided in this Material Safety Data Sheet, per the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200) and State equivalent standards.					

NE = Not Established C = Ceiling Limit See Section 16 for Definitions of Terms Used

NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1993 format.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Hydrogen Sulfide is a toxic, flammable gas and has a distinct "rotten-egg" smell. Hydrogen Sulfide is a colorless liquid which rapidly turns into a gas at standard atmospheric temperatures and pressures. Inhalation of high concentrations of this gas can result in unconsciousness, coma, and death. Contact with rapidly expanding gases, or contact with the liquid, may cause frostbite. Both the liquid and gas pose a serious fire hazard when accidentally released. The gas is heavier than air and may spread long distances. Distant ignition and flashback are possible. Flame or high temperature impinging on a localized area of the cylinder of Hydrogen Sulfide can cause the cylinder to rupture without activating the cylinder's relief devices. Provide adequate fire protection during emergency response situations.

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant route of overexposure for Hydrogen Sulfide is by inhalation. The following paragraphs describe symptoms of exposure by route of exposure.

INHALATION: Inhalation of high concentrations of Hydrogen Sulfide can cause dizziness, headache, and nausea. Exposure to higher concentrations can result in respiratory arrest, coma, or unconsciousness. Exposure for more than 30 minutes at concentrations of greater than 600 ppm have been fatal. Continuous inhalation of low concentrations may cause olfactory fatigue, so that the odor is no longer an effective warning of the presence of Hydrogen Sulfide. A summary of exposure concentrations and observed effects are as follows:

CONCENTRATION	EXPOSURE SYMPTOM
0.3-30 ppm:	Odor is obvious and unpleasant.
50 ppm:	Eye irritation. Dryness and irritation of nose, throat.
Slightly higher than 50 ppm:	Irritation of the respiratory system.
100-150 ppm:	Temporary loss of smell.
200-250 ppm:	Headache, vomiting nausea. Prolonged exposure may lead to lung damage. Exposures of 4-8 hours can be fatal.
300-500:	Swifter onset of symptoms. Death occurs in 1-4 hours.
500 ppm:	Headache, excitement, staggering, stomach after brief exposure. Death occurs from 0.5 - 1 hour.
> 600 ppm:	Rapid onset of unconsciousness, coma, death.
> 1000 ppm:	Immediate respiratory arrest.

HAZARDOUS MATERIAL INFORMATION SYSTEM

HEALTH	(BLUE)	4
FLAMMABILITY	(RED)	4
REACTIVITY	(YELLOW)	0
PROTECTIVE EQUIPMENT		D

EYES	RESPIRATORY	HANDS	BODY
	See Section 8		See Section 8

For routine industrial applications

See Section 16 for Definition of Ratings

Severe exposures which do not result in death may cause long-term symptoms such as memory loss, paralysis of facial muscles, or nerve tissue damage.

SKIN and EYE CONTACT: The gas may be irritating to the skin. Inflammation and irritation of the eyes can occur at very low airborne concentration (less than 10 ppm). Exposure over several hours may result in "gas eyes" or "sore eyes" with symptoms of scratchiness, irritation, tearing and burning. Above 50 ppm, there is an intense tearing, blurring of vision, and pain when looking at light. Exposed individuals may see rings around bright lights. Most symptoms disappear when exposure ceases. However, in serious cases, the eyes can be permanently damaged.

OTHER POTENTIAL HEALTH EFFECTS: Contact with liquid or rapidly expanding gases (which are released under high pressure) may cause frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after such contact can quickly subside.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. Overexposure to Hydrogen Sulfide may cause the following health effects:

ACUTE: Hydrogen Sulfide is irritating to the skin and eyes. Inhalation of high concentrations of Hydrogen Sulfide can cause dizziness, headache, and nausea. Exposure to higher concentrations can result in respiratory arrest, coma, or unconsciousness, and death. Contact with liquid or rapidly expanding gases may cause frostbite.

CHRONIC: Severe exposures which do not result in death may cause long-term symptoms such as memory loss, paralysis of facial muscles, or nerve tissue damage. Chronic overexposure may cause permanent eye damage.

TARGET ORGANS: Respiratory system, skin, eyes, central nervous system.

PART II *What should I do if a hazardous situation occurs?*

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO HYDROGEN SULFIDE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus and gloves should be worn. Under some response circumstances, Fire-Retardant Personal Protective equipment may be necessary. Adequate fire protection must be provided during rescue situations.

Remove victim(s) to fresh air as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. Only trained personnel should administer supplemental oxygen.

In case of frostbite, place the frostbitten part in warm water. DO NOT USE HOT WATER. If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area in the armpit. Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention.

SKIN EXPOSURE: If liquid is spilled on skin, or if irritation of the skin develops after exposure to liquid or gas, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim must seek immediate medical attention.

EYE EXPOSURE: If liquid is splashed into eyes, or if irritation of the eye develops after exposure to liquid or gas, open victim's eyes while under gentle running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes.

Victim(s) must be taken for medical attention. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to physician or other health professional with victim(s).

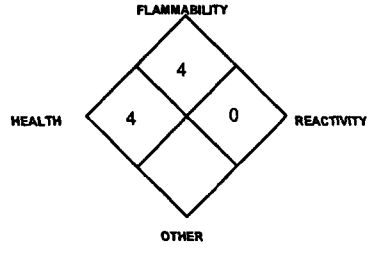
5. FIRE-FIGHTING MEASURES

FLASH POINT: Not applicable. Hydrogen Sulfide is a flammable gas.
AUTOIGNITION TEMPERATURE: 260°C (500°F)
FLAMMABLE LIMITS (in air by volume, %):

Lower (LEL): 4.0%
Upper (UEL): 44.0%

FIRE EXTINGUISHING MATERIALS: Extinguish Hydrogen Sulfide fires by shutting-off the source of the gas. Use water spray to cool fire-exposed containers, structures, and equipment. Other appropriate extinguishing media are dry chemical, foam, and carbon dioxide.

NFPA RATING



See Section 16 for Definition of Ratings

UNUSUAL FIRE AND EXPLOSION HAZARDS: Hydrogen Sulfide is a flammable, toxic gas and presents an extreme hazard to firefighters. The products of thermal decomposition of this material include water and sulfur dioxide. This gas is heavier than air; it can travel a long distance to a source of ignition and flash back.

DANGER! Fires impinging (direct flame) on the outside surface of unprotected pressure storage vessels of Hydrogen Sulfide can be very dangerous. Direct flame exposure on the cylinder wall can cause cylinder failure. For massive fires in large areas, use unmanned hose.

Explosion Sensitivity to Mechanical Impact: Not sensitive.
Explosion Sensitivity to Static Discharge: Static discharge may cause Hydrogen Sulfide to ignite explosively.

SPECIAL FIRE-FIGHTING PROCEDURES: Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. The best fire-fighting technique may be simply to let the burning gas escape from the pressurized cylinder, tank car, or pipeline. Stop the leak before extinguishing fire. If the fire is extinguished before the leak is sealed, the leaking gas could explosively re-ignite without warning and cause extensive damage, injury, or fatality. In this case, increase ventilation (in enclosed areas) to prevent flammable mixture formation. If water is not available for cooling or protection of vessel exposures, evacuate the area. Refer to the North American Emergency Response Guidebook (Guide #117) for additional information.

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a release, clear the affected area, protect people, and respond with trained personnel. Adequate fire protection must be provided.

Minimum Personal Protective Equipment should be **Level B: fire-retardant protective clothing, mechanical resistant gloves and Self-Contained Breathing Apparatus.** Use only non-sparking tools and equipment. Locate and seal the source of the leaking gas. Protect personnel attempting the shut-off with water-spray. Allow the gas to dissipate. Monitor the surrounding area for levels of combustible gas, Hydrogen Sulfide, and oxygen. Combustible gas concentration must be below 10% of the LEL (LEL = 4.0%) prior to entry. A colorimetric tube is available for Hydrogen Sulfide. If a colorimetric tube is used to indicate the concentration of Hydrogen Sulfide, the reading obtained should be lower than the limits indicated in Section 2 (Composition and Information on Ingredients). The atmosphere must have at least 19.5 percent oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus (SCBA).

Attempt to close the main source valve prior to entering the area. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in place or remove it to a safe area and allow the gas to be released there.

THIS IS AN EXTREMELY FLAMMABLE, TOXIC GAS. Protection of all personnel and the area must be maintained.

PART II *What should I do if a hazardous situation occurs?*

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting Hydrogen Sulfide IN YOU. Do not eat or drink while handling chemicals. Be aware of any signs of effects of exposure indicated in Section 3 (Hazard Identification); exposures to fatal concentrations of Hydrogen Sulfide could occur rapidly. Working alone with Hydrogen Sulfide should be avoided when possible. All work operations should be monitored in such a way that emergency personnel can be immediately contacted in the event of a release.

STORAGE AND HANDLING PRACTICES: Cylinders should be stored in dry, well-ventilated areas away from sources of heat. Compressed gases can present significant safety hazards. Store containers away from heavily trafficked areas and emergency exits. Post "No Smoking or Open Flames" signs in storage or use areas. Store Hydrogen Sulfide cylinders away from incompatible materials, such as strong oxidizers, metals, and metal oxides.

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Protect cylinders against physical damage. Store in cool, dry, well-ventilated area, away from sources of heat, ignition and direct sunlight. Do not allow area where cylinders are stored to exceed 52°C (125°F). Use a check valve or trap in the discharge line to prevent hazardous backflow. Post "No Smoking or Open Flame" signs in storage and use areas. Cylinders should be stored upright and be firmly secured to prevent falling or being knocked over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Never tamper with pressure relief devices in valves and cylinders. Electrical equipment should be non-sparking or explosion proof. The following rules are applicable to situations in which cylinders are being used:

Before Use: Move cylinders with a suitable hand truck. Do not drag, slide, or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap, if provided, in-place until cylinder is ready for use.
During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the product from the cylinder. Use check valve or trap in discharge line to prevent hazardous backflow into the cylinder. Do not use oils or grease on gas-handling fittings or equipment.
After Use: Close main cylinder valve. Replace valve protection cap, if provided. Mark empty cylinders "EMPTY".

NOTE: Use only DOT or ASME code containers. Earth-ground and bond all lines and equipment associated with Hydrogen Sulfide. Close valve after each use and when empty. Cylinders must not be recharged except by or with the consent of owner. For additional information refer to the Compressed Gas Association Pamphlet P-1, *Safe Handling of Compressed Gases in Containers*. Additionally, refer to CGA Bulletin SB-2 "*Oxygen Deficient Atmospheres*" and CGA Pamphlet G-12, "*Hydrogen Sulfide*".

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain application equipment is locked and tagged-out safely. Purge gas handling equipment with inert gas (e.g. nitrogen) before attempting repairs.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation. Local exhaust ventilation is preferred, because it prevents Hydrogen Sulfide dispersion into the work place by eliminating it at its source. If appropriate, install automatic monitoring equipment to detect the level of Hydrogen Sulfide, the presence of potentially explosive air-gas mixtures, and oxygen. Eye wash stations/safety showers should be near areas where Hydrogen Sulfide is used or stored.

RESPIRATORY PROTECTION: Maintain Hydrogen Sulfide levels below the exposure limits provided in Section 2 (Composition and Information on Ingredients) and oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection during emergency response to a release of Hydrogen Sulfide. If respiratory protection is required, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent State standards. The following NIOSH respiratory protection recommendations for Hydrogen Sulfide are provided for additional information.

CONCENTRATION of HYDROGEN SULFIDE	**RESPIRATORY EQUIPMENT**
Up to 100 ppm:	Powered air-purifying respirator with cartridge(s) to protect against Hydrogen Sulfide, gas mask with canister to protect against Hydrogen Sulfide, Supplied Air Respirator (SAR), or full-facepiece Self-Contained Breathing Apparatus (SCBA).
Emergency or Planned Entry into Unknown Concentration or IDLH Conditions:	Positive pressure, full-facepiece SCBA or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.
Escape:	Gas mask with canister to protect against Hydrogen Sulfide or escape-type SCBA

The IDLH concentration for Hydrogen Sulfide is 100 ppm.

EYE PROTECTION: Splash goggles or safety glasses, for protection from rapidly expanding gases and splashes of Liquid Hydrogen Sulfide. Additionally, face-shields should be worn if there is a potential for contact with liquid Hydrogen Sulfide.

HAND PROTECTION: Wear mechanical resistant gloves when handling cylinders of Hydrogen Sulfide. Wear chemical resistant gloves when using this gas. Butyl rubber, chlorinated polyethylene, neoprene nitrile, and polyvinyl rubber are recommended.

BODY PROTECTION: Use body protection appropriate for task. Coveralls may be appropriate if splashes from the liquefied gas are anticipated. Transfer of large quantities under pressure may require protective equipment appropriate to protect employees from splashes of liquefied product, as well as fire retardant items.

9. PHYSICAL and CHEMICAL PROPERTIES

VAPOR DENSITY: 1.406 kg/m^3 (0.0878 lb/ft^3)
SPECIFIC GRAVITY (air = 1): 1.188
SOLUBILITY IN WATER: Soluble.
EVAPORATION RATE (nBuAc = 1): Not applicable.
ODOR THRESHOLD: 0.13-100 ppm.
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.
pH: Not applicable.
FREEZING POINT: -85.5°C (-122.0°F)
BOILING POINT @ 1 atm: -60.3°C (-76.6°F)
EXPANSION RATIO: Not applicable
VAPOR PRESSURE (psia): 266.7
SPECIFIC VOLUME (ft^3/lb): 11.2

APPEARANCE AND COLOR: Colorless gas. The liquid is also colorless. The odor for both the liquid and gas is similar to that of "rotten eggs".

HOW TO DETECT THIS SUBSTANCE (warning properties): Continuous inhalation of low concentrations may cause olfactory fatigue, so that there are no distinct warning properties. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation. Wet lead acetate paper can be used for leak detection. The paper turns black in the presence of Hydrogen Sulfide. Cadmium Chloride solutions can also be used. The solution will turn yellow upon contact with Hydrogen Sulfide.

10. STABILITY and REACTIVITY

STABILITY: Stable.

DECOMPOSITION PRODUCTS: Water, sulfur dioxide.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Hydrogen Sulfide is not compatible with the following materials: oxidizing agents, organic peroxides, alkaline materials, metals (e.g., copper, lead), and metal oxides. Hydrogen Sulfide is corrosive to most metals, because it reacts with these substances to form metal sulfides.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with incompatible materials and exposure to heat, sparks and other sources of ignition Avoid exposing cylinders to extremely high temperatures, which could cause the cylinders to rupture.

PART III *How can I prevent hazardous situations from occurring?*

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following information is for Hydrogen Sulfide.

LCLo (inhalation, human) = 600 ppm/30 minutes
LDLo (inhalation, man) = 5.7 mg/kg; central nervous system, pulmonary effects
LCLo (inhalation, human) = 800 ppm/5 minutes
LC_{50} (inhalation, rat) = 444 ppm
TCLo (inhalation, rat) = 20 ppm (female, 6-22 days post), reproductive effects
LC_{50} (inhalation, mouse) = 634 ppm/1 hour
LCLo (inhalation, mammal) = 800 ppm/5 minutes

SUSPECTED CANCER AGENT: Hydrogen Sulfide is not found on the following lists: FEDERAL OSHA Z LIST, NTP, IARC, CAL/OSHA, and therefore is neither considered to be nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Hydrogen Sulfide is severely irritating to the eyes, and may be mildly to severely irritating to the skin.

SENSITIZATION TO THE PRODUCT: Hydrogen Sulfide is not known to cause sensitization in humans with prolonged or repeated contact.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of Hydrogen Sulfide and its components on the human reproductive system.

Mutagenicity: No mutagenicity effects for humans have been described for Hydrogen Sulfide.
Embryotoxicity: No embryotoxic effects for humans have been described for Hydrogen Sulfide.
Teratogenicity: No teratogenic effects for humans have been described for Hydrogen Sulfide.
Reproductive Toxicity: No reproductive toxicity effects for humans have been described for Hydrogen Sulfide. Animal reproductive data are available for Hydrogen Sulfide; these data were obtained during clinical studies on specific animal tissues exposed to this compound.

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e. within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Conditions relating to the target organs may be aggravated by overexposures to Hydrogen Sulfide. See Section 3 (Hazard Identification) for information on these conditions.

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen, if necessary. Treat symptoms and eliminate exposure. Be observant for initial signs of pulmonary edema.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for Hydrogen Sulfide.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas will be dissipated rapidly in well-ventilated areas. Additional environmental data are available for Hydrogen Sulfide as follows:

HYDROGEN SULFIDE: Water Solubility = 1 g/242 mL at 20°C

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to oxygen-deficient environments, respiratory system damage, and central nervous system effects. See Section 11 (Toxicological Information) for additional information on the effects on animals. Additional information on the effects of Hydrogen Sulfide on plants are available as follows:

Continuous fumigation of plants with 300 or 3000 ppb Hydrogen Sulfide caused leaf lesions, defoliation, and reduced growth with severity of injury correlated to dose. At higher (3.25 and 5.03 ppm) Hydrogen Sulfide, significant reductions in leaf CO2 and water vapor exchanges occurred, and stomatal openings were depressed. When Hydrogen Sulfide gas was applied to 29 species of green plants for 5 hours, young, rapidly elongating tissues were more sensitive to injury than older tissues. Symptoms included scorching of young shoots and leaves, basal and marginal scorching of older leaves. Mature leaves were unaffected. Seeds exposed to Hydrogen Sulfide gas showed delay in germination.

EFFECT OF CHEMICAL ON AQUATIC LIFE: Hydrogen Sulfide is soluble in water and is toxic to terrestrial life. Therefore, all work practices should be aimed at eliminating contamination of aquatic environments with Hydrogen Sulfide. Additional information on effects of Hydrogen Sulfide on aquatic life are as follows on the next page:

12. ECOLOGICAL INFORMATION (Continued)

EFFECT OF CHEMICAL ON AQUATIC LIFE:

TLm (Asellussp) = 0.111 mg/L/96 hour
TLm (Cranfgonyx sp) =1.07 mg/L/96 hour
TLm (Gammarrus) = 0.84 mg/L/96 hour
LC_{50} (fly inhalation) = 380 mg/m^3/960 minutes
LC_{50} (fly inhalation) = 1500 mg/m^3/7 minutes
TLm (Lepomis macrochirus, bluegill sunfish) = 0.0478 mg/L/96 hour
TLm (Lepomis macrochirus, bluegill sunfish) = 0.0448 mg/L/96 hour at 21-22 °C
TLm (Pimephlaes promelas, fathead minnow) = 0.0071-0.55 mg/L/96 hour
TLm (Salvenilis foninalis, brook trout) = 0.0160-0.515 mg/L/96 hour at 6-12.5 °C
LC_{50} (goldfish, *Carassius auratus*) = 51-95 mg/L, flow-through test, varied oxygen, 96 hours
LC_{50} (white suckers, *Catastonius commersonii*) = 0.018-0.034 mg/L, 24-120 hours, flow-through test
LC_{50} (northern pike, *Esox lucius)* = 0.026-0.159 mg/L, 96-24 hours, flow-through test
LC_{50} (walleye, *Stizostedion vitreum)* = 0.007-0.020 mg/L, 72-96 hours, flow-through test
LC_{50} (bluegill, *Lepomis macrochirus*) = 0.0090-0.032 mg/L, 96 hours, temperatures 8-22°C

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Product removed from the cylinder must be disposed of in accordance with appropriate Federal, State, and local regulations. Return cylinders with residual product to Airgas. Do not dispose locally.

14. TRANSPORTATION INFORMATION

THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: Hydrogen sulfide, liquefied
HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Poison Gas)
UN IDENTIFICATION NUMBER: UN 1053
PACKING GROUP: Not Applicable
DOT LABEL(S) REQUIRED: Poison Gas, Flammable Gas
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 117
SPECIAL PROVISION: Hydrogen Sulfide is poisonous by inhalation. Shipments must be properly described as inhalation hazards. ZONE B.
MARINE POLLUTANT: Hydrogen Sulfide is not classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B).

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: THIS MATERIAL IS CONSIDERED AS DANGEROUS GOODS. Use the above information for the preparation of Canadian Shipments. Note: There is an alternative shipping name spelling for Canadian shipments: Hydrogen Sulphide.

15. REGULATORY INFORMATION

U.S. SARA REPORTING REQUIREMENTS: Hydrogen Sulfide is subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act, as follows:

CHEMICAL NAME	SARA 302 (40 CFR 355, Appendix A)	SARA 304 (40 CFR Table 302.4)	SARA 313 (40 CFR 372.65)
Hydrogen Sulfide	YES	YES	YES

U.S. SARA THRESHOLD PLANNING QUANTITY: Hydrogen Sulfide = 500 lb.

U.S. CERCLA REPORTABLE QUANTITY (RQ): Hydrogen Sulfide CERCLA RQ = 100 lb; Hydrogen Sulfide EHS (Extremely Hazardous Substance) RQ = 100 lb; Hydrogen Sulfide RCRA Code = U135.

CANADIAN DSL/NDSL INVENTORY STATUS: Hydrogen Sulfide is on the DSL Inventory.

U.S. TSCA INVENTORY STATUS: Hydrogen Sulfide is listed on the TSCA Inventory.

OTHER U.S. FEDERAL REGULATIONS: Hydrogen Sulfide is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity for this gas is 10,000 lb. Compliance with the OSHA Process Safety Standard (29 CFR 1910.119) may be applicable to operations involving the use of Hydrogen Sulfide. Under this regulation Hydrogen Sulfide is listed in Appendix A. The Threshold Quantity of Hydrogen Sulfide under this regulation is 1500 lb.

15. REGULATORY INFORMATION (Continued)

U.S. STATE REGULATORY INFORMATION: Hydrogen Sulfide is covered under specific State regulations, as denoted below:

Alaska - Designated Toxic and Hazardous Substances: Hydrogen Sulfide.
California - Permissible Exposure Limits for Chemical Contaminants: Hydrogen Sulfide.
Florida - Substance List: Hydrogen Sulfide.
Illinois - Toxic Substance List: Hydrogen Sulfide.
Kansas - Section 302/313 List: Hydrogen Sulfide.
Massachusetts - Substance List: Hydrogen Sulfide.
Michigan - Critical Materials Register: Hydrogen Sulfide.
Minnesota - List of Hazardous Substances: Hydrogen Sulfide.
Missouri - Employer Information/Toxic Substance List: Hydrogen Sulfide.
New Jersey - Right to Know Hazardous Substance List: Hydrogen Sulfide.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: Hydrogen Sulfide.
Pennsylvania - Hazardous Substance List: Hydrogen Sulfide.
Rhode Island - Hazardous Substance List: Hydrogen Sulfide.
Texas - Hazardous Substance List: Hydrogen Sulfide.
West Virginia - Hazardous Substance List: Hydrogen Sulfide.
Wisconsin - Toxic and Hazardous Substances: Hydrogen Sulfide.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Hydrogen Sulfide is not on the California Proposition 65 lists.

LABELING:

DANGER: POISONOUS, FLAMMABLE LIQUID AND GAS UNDER PRESSURE.
MAY BE FATAL IF INHALED.
CAN FORM EXPLOSIVE MIXTURES WITH AIR.
MAY CAUSE RESPIRATORY TRACT AND CENTRAL NERVOUS SYSTEM DAMAGE.
CAN CAUSE EYE IRRITATION.
GAS DEADENS SENSE OF SMELL.
SYMPTOMS MAY BE DELAYED.

ODOR: ROTTEN EGGS.

Do not breath gas.
Do not depend on odor to detect presence of gas.
Store and use with adequate ventilation, and use in closed systems.
Keep away from heat, flames, and sparks.
Avoid contact with eyes.
Cylinder temperature should not exceed 52°C (125°F).
Close valve after each use and when empty.
Use in accordance with the Material Safety Data Sheet.

POISON

CALL A PHYSICIAN

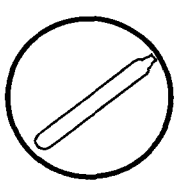
FIRST AID: **IF INHALED**, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician, even if no symptoms are present. Keep under medical observation. Symptoms may be delayed.

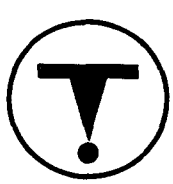
IN CASE OF CONTACT, immediately flush eyes or skin with water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician.

DO NOT REMOVE THIS PRODUCT LABEL.

CANADIAN WHMIS SYMBOLS:

Class A: Compressed Gas
Class B1: Flammable Gas
Class D1A: Toxic Material/Immediate and Serious Effects
Class D2B: Other Toxic Effects





16. OTHER INFORMATION

PREPARED BY: **Airgas - SAFECOR**

The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. AIRGAS, Inc. assumes no responsibility for injury to the vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, AIRGAS, Inc. assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in his use of the material.

DEFINITIONS OF TERMS

A large number of abbreviations and acronyms appear on a MSDS. Some of these which are commonly used include the following:

CAS #: This is the Chemical Abstract Service Number which uniquely identifies each constituent. It is used for computer-related searching.

EXPOSURE LIMITS IN AIR:
ACGIH - American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits. **TLV** - Threshold Limit Value - an airborne concentration of a substance which represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour Time Weighted Average **(TWA)**, the 15-minute Short Term Exposure Limit, and the instantaneous Ceiling Level **(C)**. Skin absorption effects must also be considered.
OSHA - U.S. Occupational Safety and Health Administration. **PEL** - Permissible Exposure Limit - This exposure value means exactly the same as a TLV, except that it is enforceable by OSHA. The OSHA Permissible Exposure Limits are based in the 1989 PELs and the June, 1993 Air Contaminants Rule (Federal Register: 58: 35338-35351 and 58: 40191). Both the current PELs and the vacated PELs are indicated. The phrase, "Vacated 1989 PEL," is placed next to the PEL which was vacated by Court Order.
IDLH - Immediately Dangerous to Life and Health - This level represents a concentration from which one can escape within 30-minutes without suffering escape-preventing or permanent injury. **The DFG - MAK** is the Republic of Germany's Maximum Exposure Level, similar to the U.S. PEL. **NIOSH** is the National Institute of Occupational Safety and Health, which is the research arm of the U.S. **O**ccupational **S**afety and **H**ealth **A**dministration (**OSHA**). NIOSH issues exposure guidelines called **R**ecommended **E**xposure **L**evels (**RELs**). When no exposure guidelines are established, an entry of **NE** is made for reference.

HAZARD RATINGS:
HAZARDOUS MATERIALS IDENTIFICATION SYSTEM: Health Hazard: **0** (minimal acute or chronic exposure hazard); **1** (slight acute or chronic exposure hazard); **2** (moderate acute or significant chronic exposure hazard); **3** (severe acute exposure hazard; onetime overexposure can result in permanent injury and may be fatal); **4** (extreme acute exposure hazard; onetime overexposure can be fatal). Flammability Hazard: **0** (minimal hazard); **1** (materials that require substantial pre-heating before burning); **2** (combustible liquid or solids; liquids with a flash point of 38-93°C [100-200°F]); **3** (Class IB and IC flammable liquids with flash points below 38°C [100°F]); **4** (Class IA flammable liquids with flash points below 23°C [73°F] and boiling points below 38°C [100°F]. Reactivity Hazard: **0** (normally stable); **1** (material that can become unstable at elevated temperatures or which can react slightly with water); **2** (materials that are unstable but do not detonate or which can react violently with water); **3** (materials that can detonate when initiated or which can react explosively with water); **4** (materials that can detonate at normal temperatures or pressures).
NATIONAL FIRE PROTECTION ASSOCIATION: Health Hazard: **0** (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure causes death or major residual injury).

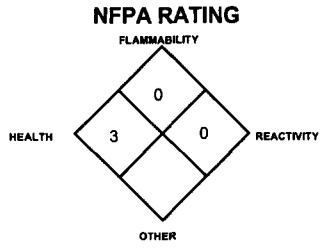
NATIONAL FIRE PROTECTION ASSOCIATION (Continued): Flammability Hazard and Reactivity Hazard: Refer to definitions for "Hazardous Materials Identification System".

FLAMMABILITY LIMITS IN AIR:
Much of the information related to fire and explosion is derived from the National Fire Protection Association **(NFPA)**. Flash Point - Minimum temperature at which a liquid gives off sufficient vapors to form an ignitable mixture with air. Autoignition Temperature: The minimum temperature required to initiate combustion in air with no other source of ignition. LEL - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. UEL - the highest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source.

TOXICOLOGICAL INFORMATION:
Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms used in this section are: **LD_{50}** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC_{50}** - Lethal Concentration (gases) which kills 50% of the exposed animals; **ppm** concentration expressed in parts of material per million parts of air or water; **mg/m^3** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Data from several sources are used to evaluate the cancer-causing potential of the material. The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TDo**, **LDLo**, and **LDo**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **BEI** - Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV. Ecological Information: EC is the effect concentration in water.

REGULATORY INFORMATION:
This section explains the impact of various laws and regulations on the material. **EPA** is the U.S. Environmental Protection Agency. **WHMIS** is the Canadian Workplace Hazardous Materials Information System. **DOT** and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively. Superfund Amendments and Reauthorization Act **(SARA)**; the Canadian Domestic/Non-Domestic Substances List **(DSL/NDSL)**; the U.S. Toxic Substance Control Act **(TSCA)**; Marine Pollutant status according to the **DOT**; the Comprehensive Environmental Response, Compensation, and Liability Act **(CERCLA or Superfund)**; and various state regulations.

MATERIAL SAFETY DATA SHEET



Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards

PART I *What is the material and what do I need to know in an emergency?*

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: **SULFUR DIOXIDE - SO_2**
Document Number: 1047

PRODUCT USE: For general analytical/synthetic chemical uses.

SUPPLIER/MANUFACTURER'S NAME: AIRGAS INC.
ADDRESS: 259 Radnor-Chester Road
Suite 100
Radnor, PA 19087-5240

BUSINESS PHONE: 1-610-687-5253
EMERGENCY PHONE: CHEMTREC: 1-800-424-9300
International: 202-483-7616

DATE OF PREPARATION: May 20, 1996
SECOND REVISION: January 23, 1998

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH		OSHA			
			TLV ppm	STEL ppm	PEL ppm	STEL ppm	IDLH ppm	OTHER
Sulfur Dioxide	7446-09-5	> 99.98 %	2, A4 (Not Classifiable as Human Carcinogen)	5	5 2 (Vacated 1989 PEL)	5 (Vacated 1989 PEL)	100	NIOSH REL: 2 ppm TWA; 5 ppm STEL DFG-MAK: 2 ppm TWA
Maximum Impurities		< 0.02%	None of the trace impurities in this mixture contribute significantly to the hazards associated with the product. All hazard information pertinent to this product has been provided in this Material Safety Data Sheet, per the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200) and State equivalent standards.					

NE = Not Established C = Ceiling Limit See Section 16 for Definitions of Terms Used

NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1993 format.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Sulfur Dioxide is a colorless, non-flammable, toxic gas with a distinct odor similar to burning sulfur. Sulfur Dioxide is shipped as a liquid which rapidly turns into a gas at standard atmospheric temperatures and pressures. Sulfur Dioxide is irritating to the respiratory system and to contaminated skin and eyes. Exposure to high concentrations of this gas may be fatal. Contact with rapidly expanding gases, or contact with the liquid, may cause frostbite. The gas reacts with water or moisture to generate sulfurous acid, which can also be corrosive to contaminated tissue.

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant route of overexposure for Sulfur Dioxide is by inhalation. The following paragraphs describe symptoms of exposure by route of exposure.

INHALATION: Exposure to Sulfur Dioxide gas in low concentrations produces an irritating effect on the mucous membranes of the eyes, nose, throat, and lungs due to the formation of sulfurous acid when it comes into contact with moist tissues or moist air. Acute exposure through inhalation may result in dryness and irritation of the nose and throat, choking, coughing, and bronchospasm. Severe overexposure may cause death through systemic acidosis, pulmonary edema, or from respiratory arrest. High concentrations of Sulfur Dioxide gas may cause an oxygen deficient atmosphere. Exposure to high concentrations may cause unconsciousness, and under some circumstances, death.

Prolonged or repeated overexposures may cause impaired lung function, bronchitis, hacking cough, nasal irritation and discharge, increased fatigue, alteration in the senses of taste and smell. Repeated over exposures to Sulfur Dioxide can also result in dental erosion and gum disorders.

SKIN and EYE CONTACT: The gas may be irritating to the skin, especially in a moist environment. Symptoms of skin overexposure may include scratchiness, pain, and redness. If Sulfur Dioxide contaminates the eyes, damage to eye tissue will result in pain, inflammation, and potentially, blindness. Liquid Sulfur Dioxide will be very corrosive to contaminated skin and eye tissue, producing the same symptoms as described for the gas, but with the on-set of symptoms occurring more rapidly. Eye injury from contact with liquid Sulfur Dioxide may not be immediately noticed because of the damage which can occur to the optical nerves. Contact with liquid or rapidly expanding gases (which are released under high pressure) may cause frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after such contact can quickly subside.

HAZARDOUS MATERIAL INFORMATION SYSTEM

HEALTH	(BLUE)	3
FLAMMABILITY	(RED)	0
REACTIVITY	(YELLOW)	0
PROTECTIVE EQUIPMENT		H

EYES	RESPIRATORY	HANDS	BODY
	See Section 8		See Section 8

For routine industrial applications

See Section 16 for Definition of Ratings

OTHER POTENTIAL HEALTH EFFECTS: While ingestion is highly unlikely, ingestion of Sulfur Dioxide can damage the tissues of the mouth, throat, esophagus, and other tissues of the digestive system. Ingestion of Sulfur Dioxide can be fatal. Additionally, aspiration by inhalation is possible, causing chemical pneumonia or death.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. Overexposure to Sulfur Dioxide may cause the following health effects:

ACUTE: This gas is toxic and damaging to the respiratory system as well as contaminated skin and eyes. Overexposures can result in severe irritation and burns of eyes, skin, mucous membranes, and any other exposed tissue. If inhaled, irritation of the respiratory system may occur, with coughing, and breathing difficulty. Overexposure to this gas may be fatal. Though unlikely to occur during occupational use, ingestion of large quantities may be fatal. Contact with liquid or rapidly expanding gases may cause frostbite.

CHRONIC: Prolonged or repeated overexposures may cause respiratory problems, bronchitis, hacking cough, nasal irritation and discharge, increased fatigue, alteration in the senses of taste and smell. Repeated over exposures to Sulfur Dioxide can also result in dental erosion and gum disorders.

TARGET ORGANS: Respiratory system, skin, eyes, central nervous system.

PART II *What should I do if a hazardous situation occurs?*

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO SULFUR DIOXIDE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus and Personal Protective Equipment should be worn

Remove victim(s) to fresh air, as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. Only trained personnel should administer supplemental oxygen.

SKIN EXPOSURE: If Sulfur Dioxide contaminates the skin, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim must seek immediate medical attention.

Note: if frostbite has occurred after exposure to rapidly expanding gases, treatment for frostbite should be initiated after the contaminated areas has been flushed (per the instructions in the previous paragraph). In case of frostbite, place the frostbitten part in warm water. DO NOT USE HOT WATER. If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area in the armpit. Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention.

EYE EXPOSURE: If liquid is splashed into eyes, or if irritation of the eye develops after exposure to liquid or gas, open victim's eyes while under gentle running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes.

Victim(s) must be taken for medical attention. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to physician or other health professional with victim(s). Refer to "Recommendations to Physicians," Section 11 (Toxicological Information) for additional information on first-aid measures.

5. FIRE-FIGHTING MEASURES

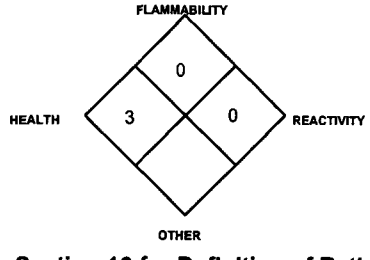
FLASH POINT: Not applicable.
AUTOIGNITION TEMPERATURE: Not applicable.
FLAMMABLE LIMITS (in air by volume, %):

Lower (LEL): Not applicable.
Upper (UEL): Not applicable.

FIRE EXTINGUISHING MATERIALS: Use extinguishing media appropriate for the surrounding fire.

Water Spray: YES	Carbon Dioxide: YES	Foam: YES
Dry Chemical: YES	Halon: YES	Other: Any "ABC" Class.

NFPA RATING



See Section 16 for Definition of Ratings

UNUSUAL FIRE AND EXPLOSION HAZARDS: Sulfur Dioxide is a toxic gas and presents a significant health hazard to firefighters. In the event of fire, cool containers of Sulfur Dioxide with water to prevent failure. Use a water spray or fog to reduce or direct vapors. Do not direct a water spray at the source of a release. Water spray should be used with care. Sulfur Dioxide can react with water to form a corrosive solution of sulfurous acid. Sulfurous acid can corrode metal.

Explosion Sensitivity to Mechanical Impact: Not sensitive.
Explosion Sensitivity to Static Discharge: Not sensitive.

SPECIAL FIRE-FIGHTING PROCEDURES: Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Fight fires in a protected location. Approach fire from an upwind direction, to prevent overexposure to Sulfur Dioxide. If Sulfur Dioxide is involved in a fire, fire runoff water should be contained to prevent possible environmental damage. If unruptured cylinders are exposed to heat, the cylinder may rupture or burst and release the contents. It may be prudent to remove potentially heat-exposed cylinders from the area surrounding a fire, if it is safe for firefighters to do so.

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a release, clear the affected area, protect people, and respond with trained personnel. Adequate fire protection must be provided. Call CHEMTREC (1-800-424-9300) for emergency assistance.

Minimum Personal Protective Equipment should be **Level B: triple-gloves (rubber gloves and nitrile gloves, over latex gloves), chemically resistant suit and boots, hard-hat, and Self-Contained Breathing Apparatus.** A colorimetric tube is available for Sulfur Dioxide. If a colorimetric tube is used to indicate the concentration of Sulfur Dioxide, the reading obtained should be lower than the limits indicated in Section 2 (Composition and Information on Ingredients) before non-emergency personnel are permitted into area. Monitor the surrounding area for oxygen. The atmosphere must have at least 19.5 percent oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus (SCBA).

Attempt to close the main source valve prior to entering the area. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in-place or remove it to a safe area and allow the gas to be released there.

THIS IS A TOXIC GAS. Protection of all personnel and the area must be maintained.

PART III *How can I prevent hazardous situations from occurring?*

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting Sulfur Dioxide ON YOU or IN YOU. Wash hands after handling chemicals. Do not eat or drink while handling chemicals. All work practices should minimize the release of Sulfur Dioxide. Be aware of any signs of exposure as indicated in Section 2 (Composition and Information on Ingredients); exposures to fatal concentrations of Sulfur Dioxide could occur rapidly.

STORAGE AND HANDLING PRACTICES: All employees who handle this material should be trained to handle it safely. Avoid breathing the gas or sprays or mists generated by Sulfur Dioxide. Store containers in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Use only compatible materials for cylinders, process lines, and other Sulfur Dioxide-handling equipment. Anhydrous Sulfur Dioxide is not corrosive to steel and other common structural materials, except zinc. In the presence of moisture, however, corrosive conditions will develop. Lead, carbon, graphite, and stainless steel, type 316 are recommended for handling moist Sulfur Dioxide. Lines should be purged with dry nitrogen both before and after maintenance activity. Keep cylinder tightly closed when not in use. Keep cylinders away from incompatible material. Wash thoroughly after using this material. Workers must be thoroughly trained to handle Sulfur Dioxide without causing overexposure. Periodic inspections of process equipment by knowledgeable persons should be made to ensure that the equipment is used appropriately and the system is kept in suitable operating condition. Sulfur Dioxide emergency equipment should be available near the point of use.

- Workers who handle Sulfur Dioxide should wear protective clothing, as listed in Section 8 (Exposure Controls - Personal Protection).
- Instant-acting showers should be available in the event of an emergency.
- Special eye-wash fountains or similar equipment should be available for eye irrigation.
- Proper respiratory protection equipment must be provided and workers using such equipment must be carefully trained in its operation and limitations.
- Precautions must always be taken to prevent suck-back of foreign materials into the cylinder by using a check-valve, vacuum break, or trap, since suck-back may cause dangerous pressure changes within the cylinder.
- The cylinder valve should be closed after each use.

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Protect cylinders against physical damage. Store in cool, dry, well-ventilated area, away from sources of heat, ignition and direct sunlight. Do not allow area where cylinders are stored to exceed 52°C (125°F). Use a check valve or trap in the discharge line to prevent hazardous backflow. Post "No Smoking or Open Flame" signs in storage and use areas. Cylinders should be stored upright and be firmly secured to prevent falling or being knocked over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Never tamper with pressure relief devices. The rules following on the following page are applicable to situations in which cylinders are being used:

7. HANDLING and STORAGE (Continued)

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS (continued):

Before Use: Move cylinders with a suitable hand-truck. Do not drag, slide or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap, if provided, in-place until cylinder is ready for use.

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the product from the cylinder. Use check valve or trap in discharge line to prevent hazardous backflow into the cylinder. Do not use oils or grease on gas-handling fittings or equipment.

After Use: Close main cylinder valve. Replace valve protection cap, if provided. Mark empty cylinders "EMPTY".

NOTE: Use only DOT or ASME code containers. Close valve after each use and when empty. Cylinders must not be recharged except by or with the consent of owner. For additional information refer to the Compressed Gas Association Pamphlet P-1, *Safe Handling of Compressed Gases in Containers*. Additionally, refer to CGA Bulletin SB-2 "*Oxygen Deficient Atmospheres*" and CGA Pamphlet G-3, "*Sulfur Dioxide*".

TANK CAR SHIPMENTS: Tank cars carrying Sulfur Dioxide should be loaded and unloaded in strict accordance with tank-car manufacturer's recommendations and all established on-site safety procedures. Appropriate personal protective equipment must be used during tank car operations (see Section 8, Exposure Controls - Personal Protection). All loading and unloading equipment must be inspected, prior to each use. Loading and unloading operations must be attended, at all times. Tank cars must be level and wheels must be locked or blocked prior to loading or unloading. Tank car (for loading) or storage tank (for unloading) must be verified to be correct for receiving Sulfur Dioxide and be properly prepared, prior to starting the transfer operations. Hoses must be verified to be clean and free of incompatible chemicals, prior to connection to the tank car or vessel. Valves and hoses must be verified to be in the correct positions, before starting transfer operations. A sample (if required) must be taken and verified (if required) prior to starting transfer operations. All lines must be blown-down and purged before disconnecting them from the tank car or vessel.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain application equipment is locked and tagged-out safely. Purge gas handling equipment with inert gas (e.g., nitrogen) before attempting repairs.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation. Local exhaust ventilation is preferred, because it prevents Sulfur Dioxide dispersion into the work place by eliminating it at its source. If appropriate, install automatic monitoring equipment to detect the level of Sulfur Dioxide and oxygen. Eye wash stations/safety showers should be near areas where Sulfur Dioxide is used or stored.

RESPIRATORY PROTECTION: Maintain Sulfur Dioxide below the exposure limits provided in Section 2 (Composition and Information on Ingredients) and oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection during emergency response to a release of Sulfur Dioxide or if oxygen levels are below 19.5%. If respiratory protection is required, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent State standards. The following NIOSH recommendations for Sulfur Dioxide concentrations in air are in place.

CONCENTRATION	RESPIRATORY EQUIPMENT
Up to 20 ppm:	Chemical cartridge respirator with cartridge(s); or Supplied Air Respirator (SAR).
Up to 50 ppm:	Powered air-purifying respirator with cartridge(s); or SAR operated in continuous-flow mode.
Up to 100 ppm:	Full-Facepiece chemical cartridge respirator with cartridge(s); or gas mask with canister; or powered air-purifying respirator with a tight-fitting facepiece and cartridge(s); or full-facepiece Self-Contained Breathing Apparatus (SCBA); or full-facepiece SAR; or SAR with a tight-fitting facepiece operated in a continuous-flow mode.
Emergency or Planned Entry into Unknown Concentration or IDLH Conditions:	Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

The IDLH concentration for Sulfur Dioxide is 100 ppm.

EYE PROTECTION: Splash goggles or safety glasses, for protection from rapidly expanding gases and splashes of Liquid Sulfur Dioxide. Additionally, face-shields should be worn if there is a potential for contact with liquid Sulfur Dioxide.

HAND PROTECTION: Wear mechanically-resistant gloves when handling cylinders of Sulfur Dioxide. Wear chemically-resistant gloves when using this gas. Butyl rubber, chlorinated polyethylene, neoprene are recommended.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

BODY PROTECTION: Use body protection appropriate for task. Coveralls may be appropriate if splashes from the liquefied gas are anticipated. Transfer of large quantities under pressure may require protective equipment appropriate to protect employees from splashes of liquefied product.

9. PHYSICAL and CHEMICAL PROPERTIES

VAPOR DENSITY: 2.668 kg/m^3 (0.1665 lb/ft^3)
SPECIFIC GRAVITY (air = 1): 2.263
SOLUBILITY IN WATER: Converts to soluble sulfurous acid.
VAPOR PRESSURE (psia): 49.1
ODOR THRESHOLD: 3-5 ppm.
pH: Not applicable. (1% solution in water will have a pH < 3).
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.
EVAPORATION RATE (nBuAc = 1): Not applicable.
FREEZING POINT: -75.5°C (-103.9°F)
BOILING POINT @ 1 atm: -10°C (14.0°F)
EXPANSION RATIO: Not available.
SPECIFIC VOLUME (ft^3/lb): 5.9

APPEARANCE AND COLOR: Colorless gas. The liquid is also colorless. The odor for both the liquid and gas is similar to that of burning sulfur.

HOW TO DETECT THIS SUBSTANCE (warning properties): Though the odor is extremely disagreeable, it does not serve as a reliable warning property for Sulfur Dioxide. The Odor Threshold is the same order of magnitude as the concentration of exposure associated with adverse health effects. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation. Wet lead acetate paper can be used for leak detection. Additionally, leaks of Sulfur Dioxide in lines or equipment may be located by passing a squeeze bottle of aqueous ammonia over sites of suspected leaks; dense, white fumes sill be formed near the leaks.

10. STABILITY and REACTIVITY

STABILITY: Stable.

DECOMPOSITION PRODUCTS: Will react with water or, moist air to form sulfurous acid.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Sulfur Dioxide is not compatible with the following materials: strong bases, strong oxidizers, powdered metals, metal oxides, sodium hydride, silver azide, cesium azide, zinc, zinc compounds, metal acetylides.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with moisture and incompatible materials. Cylinders exposed to high temperatures or direct flame can rupture or burst.

PART IV *Is there any other useful information about this material?*

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following information is for Sulfur Dioxide.

Eye, rabbit = 6 ppm/4 hours/32 days; mild effects
Mutation in Microorganisms System Test = 10 mmol/L
DNA damage System Test (human, lymphocyte) = 5700 ppb
TCLo (inhalation, mouse) = 32 ppm/ 24 hours (female 7-28 day post); reproductive effects.
TCLo (inhalation, mouse) = 25 ppm/7 hours (female 6-15 days post); teratogenic effects
TCLo (inhalation, mouse) = 500 ppm/5 minutes/30 weeks; equivocal tumorigenic data
LCLo (inhalation, human) = 1000 ppm/10 minutes; pulmonary effects
TCLo (inhalation, human) = 3 ppm/5 days; pulmonary effected
TCLo (inhalation, human) = 12 ppm/1 hour; pulmonary effects
LCLo (inhalation, human) = 3000 ppm/5 minutes
LC_{50} (inhalation, rat) = 2520 ppm/1 hour
LC_{50} (inhalation, mouse) = 3000 ppm/30 minutes
LCLo (inhalation, guinea pig) = 1039 ppm/24 hours
LCLo (inhalation, frog) = 1 pph/ 15 minutes
LCLo (inhalation, mammal) = 3,000 ppm/5 minutes
TCLo (inhalation, rat) = 4,910 mg/m^3/6 hours/17 weeks–intermittent
TCLo (inhalation, rat) = 500 mg/m^3/96 days– intermittent
TCLo (inhalation, dog) = 1 ppm/90 minutes/1 year– intermittent
TCLo (inhalation, dog) = 500 ppm/2 hours/21 weeks– intermittent
TCLo (inhalation, rabbit) = 200 mg/m^3/3 hours/13 weeks– intermittent

EYE IRRITATION: Temporary clouding of eyes was seen in rabbits, guinea pigs, and mice exposed to 400 ppm for 4 hours. Very severe eye injury in rabbits was produced by a 5-second exposure to a stream of pure sulfur dioxide.

11. TOXICOLOGICAL INFORMATION (Continued)

TOXICITY DATA (continued):

SHORT-TERM INHALATION STUDIES: Most studies indicate that high concentrations of Sulfur Dioxide effect the mechanics of respiration. A dose-related narrowing of the bronchiole tubes leading to bronchio-constriction was seen in guinea pigs exposed to concentrations of 0,2-100 ppm for 1 hour. Exposure of male mice for up to 72 hours to concentrations around 10 ppm produced nasal cavity injury (runny nose, ciliary loss, fluid accumulation, and tissue death). The effects became more severe as exposure time increased. Less severe effects were seen in the trachea and lungs. Other studies have not been reported any effects after 1-2 hour exposures to less than 1 ppm.

LONG-TERM INHALATION STUDIES: Exposure to 5 ppm for 225 days produced pulmonary function changes in dogs. Increased swelling, secretions, and reddening of the trachea, as well as decreased mucosal flow was seen in dogs intermittently exposed to 1 ppm for 12 months. There was no apparent effect on pulmonary function. No adverse effects were seen in guinea pigs exposed for 22 hours day, 7 days a week, for 52 weeks to concentrations of 0.13-5.72 ppm. No adverse effects were seen in monkeys exposed for 78 weeks to 0.14 - 1.28 ppm.

SUSPECTED CANCER AGENT: Sulfur Dioxide is not found on the following lists: FEDERAL OSHA Z LIST, NTP, IARC, CAL/OSHA; therefore it is not considered to be, nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Sulfur Dioxide is severely irritating to the eyes and may be irritating to the skin.

SENSITIZATION TO THE PRODUCT: Sulfur Dioxide is not known to cause sensitization in humans. One study involving guinea pigs exposed to 4.3 ppm Sulfur Dioxide, 8 hours/day for 5 days enhanced an allergic reaction to ovalbumin (a known allergen).

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of Sulfur Dioxide on the human reproductive system.

Mutagenicity: In terms of clinical studies in animals, the following information was obtained: Sulfur Dioxide and its aqueous forms gave both positive and negative results in bacterial test. Sulfur Dioxide did not induce sister chromatid exchange, chromosomal aberrations, or micronucleus formation in the bone marrow of mice or Chinese Hamsters in in-vivo test. However, it induced morphological transformation of Syrian hamster embryo cells. Other mutagenic data are available as follows:

oms-esc = 2 mmol/L
mmo-omi = 10 mmol/L (S9)
sln-dmg-oral = 200 mmol/L
mmo-smc = 5 mmol/L (S9)
dnd- human: lymphocytes = 5,700 ppb
dni- human: lymphocytes = 5,700 ppb
oms-human: lymphocytes = 5,700 ppb
oms-ctl: other = 2,500 mmol/L
cytogenic-dom: other = 5 mmol/L
cytogenic-ctl: other = 2,500 mmol/L

Embryotoxicity: Sulfur Dioxide is not reported to cause embryotoxic effects in humans. Refer to the following paragraph for additional information.

Teratogenicity: No teratogenicity effects on humans have been described for Sulfur Dioxide. In terms of clinical studies in animals, the following information was obtained: Slight signs of fetotoxicity were seen in mice exposed to 32, 65, 125, or 250 ppm. Slight embryotoxicity was also seen when pregnant rabbits were exposed to 70 ppm during 6-15 days of pregnancy. Slight maternal toxicity was observed in both mice and rabbits. Additional teratogenic data are available as follows:

TCLo (inhalation, rat) = 4 mg/m^3/24 hours (72-days preg)
TCLo (inhalation, rat) = 4 mg/m^3/24 hours (72-days preg)
TCLo (inhalation, rat) = 4,970 mg/m^3/12 hours (12-weeks preg)
TCLo (inhalation, rat) = 30 ppm/6 hours (21-weeks male)
TCLo (inhalation, mouse) = 25 ppm/7 hours (6-15-days preg)
TCLo (inhalation, mouse) = 25 ppm/7 hours (6–15-days preg)
TCLo (inhalation, mouse) = 32 ppm/24 hours (7–18-days preg)
TCLo (inhalation, rabbit) = 70 ppm/7 hours (6–18-days preg)

Reproductive Toxicity: No reproductive toxicity effects on humans have been described for Sulfur Dioxide.

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e. within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Conditions relating to the target organs may be aggravated by overexposures to Sulfur Dioxide. See Section 3 (Hazard Identification) for information on these conditions.

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen, treat symptoms, and reduce overexposure. Oxygen administration is most effective if expiration is made against a positive pressure of 4 cm. In cases of severe overexposure, the victim should breath 100% oxygen under positive pressure exhalation pressure for 1.2 hour every hour for 3 hours. Be observant for the initial stages of pulmonary edema or pneumonitis. In some cases, respiratory and circulatory stimulants (coramine, metrazol, and caffeine-sodium benzoate) may be of value.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for Sulfur Dioxide.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas will be dissipated rapidly in well-ventilated areas. Sulfur Dioxide is extremely stable to heat [up to 200°C (392°F)]. Complex reactions of Sulfur Dioxide occur in the atmosphere, producing sulfates and other sulfur compounds which contribute to air pollution.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to oxygen-deficient environments, respiratory system damage, and damage to the skin and eyes. Because Sulfur Dioxide produces corrosive sulfurous acid upon contact with moisture, plants may be damaged or destroyed. Frost may also be produced, in the presence of rapidly-expanding gases.

EFFECT OF CHEMICAL ON AQUATIC LIFE: Sulfur Dioxide hydrolyzes to sulfurous acid solution when in contact with water. Sulfurous acid is very soluble in water, and even low concentrations of Sulfur Dioxide or sulfurous acid in water is detrimental to aquatic life. If a release of Sulfur Dioxide occurs near a river or other body of water, the release has the potential to kill fish and other aquatic life. Additional aquatic toxicity data are available for Sulfur Dioxide, as follows:

Concentration (ppm)	Exposure (hours)	Species	Effect	Test Environment
16		sunfish	lethal	
16-19	1	sunfish	lethal	
10	0.17	trout	toxic	tap water
5		trout	lethal	
0.5	1	fish	toxic	as HSO_3
1	2	tench	lethal	as HSO_3

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Return cylinders with any residual product to Airgas Inc. Do not dispose of locally.

14. TRANSPORTATION INFORMATION

THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: Sulfur dioxide, liquefied
HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Poison Gas)
UN IDENTIFICATION NUMBER: UN 1079
PACKING GROUP: Not Applicable
DOT LABEL(S) REQUIRED: Poison Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (1996): 125
SPECIAL PROVISION: Sulfur Dioxide is poisonous by inhalation. Shipments must be properly described as inhalation hazards. ZONE C.
MARINE POLLUTANT: Sulfur Dioxide is not classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B).
TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: THIS MATERIAL IS CONSIDERED AS DANGEROUS GOODS. Use the above information for the preparation of Canadian Shipments.

SPECIAL PROVISION for CANADA: 102 (Poison-Inhalation Hazard). Emergency Response Assistance Planning requirements must be met for shipments in excess of 3,000 kg or liters.

15. REGULATORY INFORMATION

U.S. SARA REPORTING REQUIREMENTS: Sulfur Dioxide is subject to the reporting requirements of Sections 302, 304, and 313 of Title III of the Superfund Amendments and Reauthorization Act, as follows:

CHEMICAL NAME	SARA 302 (40 CFR 355, Appendix A)	SARA 304 (40 CFR Table 302.4)	SARA 313 (40 CFR 372.65)
Sulfur Dioxide	YES	YES	NO

15. REGULATORY INFORMATION (Continued)

U.S. SARA THRESHOLD PLANNING QUANTITY: Sulfur Dioxide = 500 lb.

U.S. CERCLA REPORTABLE QUANTITY (RQ): Sulfur Dioxide is listed as an EHS (Extremely Hazardous Substance); RQ = 1 lb.

CANADIAN DSL/NDSL INVENTORY STATUS: Sulfur Dioxide is on the DSL Inventory.

U.S. TSCA INVENTORY STATUS: Sulfur Dioxide is listed on the TSCA Inventory.

OTHER U.S. FEDERAL REGULATIONS: Sulfur Dioxide (anhydrous) is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity for this gas is 5,000 pounds. Compliance with the OSHA Process Safety Standard (29 CFR 1910.119) may be applicable to operations involving the use of Sulfur Dioxide. Under this regulation Sulfur Dioxide (liquid) is listed in Appendix A of this Standard and the threshold quantity for Sulfur Dioxide is 1000 pounds.

U.S. STATE REGULATORY INFORMATION: Sulfur Dioxide is covered under specific State regulations, as denoted below:

Alaska - Designated Toxic and Hazardous Substances: Sulfur Dioxide.
California - Permissible Exposure Limits for Chemical Contaminants: Sulfur Dioxide.
Florida - Substance List: Sulfur Dioxide.
Illinois - Toxic Substance List: Sulfur Dioxide.
Kansas - Section 302/313 List: Sulfur Dioxide.
Massachusetts - Substance List: Sulfur Dioxide.
Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: Sulfur Dioxide.
Missouri - Employer Information/Toxic Substance List: Sulfur Dioxide.
New Jersey - Right to Know Hazardous Substance List: Sulfur Dioxide.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.
Pennsylvania - Hazardous Substance List: Sulfur Dioxide.
Rhode Island - Hazardous Substance List: Sulfur Dioxide.
Texas - Hazardous Substance List: Sulfur Dioxide.
West Virginia - Hazardous Substance List: Sulfur Dioxide.
Wisconsin - Toxic and Hazardous Substances: Sulfur Dioxide.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Sulfur Dioxide is not on the California Proposition 65 lists.

LABELING:

DANGER: CORROSIVE LIQUID AND GAS UNDER PRESSURE.
CAN CAUSE EYE, SKIN, AND RESPIRATORY TRACT BURNS.

Avoid breathing gas.
Store and use with adequate ventilation.
Do not get in eyes, on skin or clothing.
Use only with equipment of compatible material and construction.
Cylinder temperature should not exceed 52°C (125°F).
Close valve after each use and when empty.
Use in accordance with the Material Safety Data Sheet.

NOTE: Suck-back into cylinder may cause rupture.
Always use a back flow preventative device in piping.

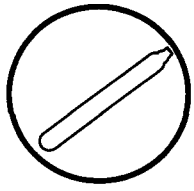
FIRST-AID: **IF INHALED**, remove to fresh air. If not breathing, give artificial respiration. (Rescuer may receive chemical burns as a result of giving mouth to mouth). If breathing is difficult, give oxygen. Call a physician. Keep under medical observation.

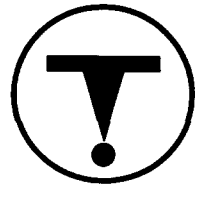
IN CASE OF CONTACT, immediately flush eyes or skin with water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse. (Discard contaminated shoes).

DO NOT REMOVE THIS PRODUCT LABEL.

CANADIAN WHMIS SYMBOLS:

Class A: Compressed Gas
Class D1A: Toxic Material/Immediate and Serious Effects
Class D2A: Other Toxic Effects/Very Toxic





16. OTHER INFORMATION

PREPARED BY:

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619/565-0302

DEFINITIONS OF TERMS

A large number of abbreviations and acronyms appear on a MSDS. Some of these which are commonly used include the following:

CAS #: This is the Chemical Abstract Service Number which uniquely identifies each constituent. It is used for computer-related searching.

EXPOSURE LIMITS IN AIR:
ACGIH - American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits. **TLV** - Threshold Limit Value - an airborne concentration of a substance which represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour Time Weighted Average **(TWA)**, the 15-minute Short Term Exposure Limit, and the instantaneous Ceiling Level **(C)**. Skin absorption effects must also be considered.
OSHA - U.S. Occupational Safety and Health Administration. **PEL** - Permissible Exposure Limit - This exposure value means exactly the same as a TLV, except that it is enforceable by OSHA. The OSHA Permissible Exposure Limits are based in the 1989 PELs and the June, 1993 Air Contaminants Rule (Federal Register: 58: 35338-35351 and 58: 40191). Both the current PELs and the vacated PELs are indicated. The phrase, "Vacated 1989 PEL," is placed next to the PEL which was vacated by Court Order.
IDLH - Immediately Dangerous to Life and Health - This level represents a concentration from which one can escape within 30-minutes without suffering escape-preventing or permanent injury. **The DFG - MAK** is the Republic of Germany's Maximum Exposure Level, similar to the U.S. PEL. **NIOSH** is the National Institute of Occupational Safety and Health, which is the research arm of the U.S. **O**ccupational **S**afety and **H**ealth **A**dministration (**OSHA**). NIOSH issues exposure guidelines called **R**ecommended **E**xposure **L**evels (**RELs**). When no exposure guidelines are established, an entry of **NE** is made for reference.

HAZARD RATINGS:
HAZARDOUS MATERIALS IDENTIFICATION SYSTEM: Health Hazard: **0** (minimal acute or chronic exposure hazard); **1** (slight acute or chronic exposure hazard); **2** (moderate acute or significant chronic exposure hazard); **3** (severe acute exposure hazard; onetime overexposure can result in permanent injury and may be fatal); **4** (extreme acute exposure hazard; onetime overexposure can be fatal). Flammability Hazard: **0** (minimal hazard); **1** (materials that require substantial pre-heating before burning); **2** (combustible liquid or solids; liquids with a flash point of 38-93°C [100-200°F]); **3** (Class IB and IC flammable liquids with flash points below 38°C [100°F]); **4** (Class IA flammable liquids with flash points below 23°C [73°F] and boiling points below 38°C [100°F]. Reactivity Hazard: **0** (normally stable); 1 (material that can become unstable at elevated temperatures or which can react slightly with water); **2** (materials that are unstable but do not detonate or which can react violently with water); **3** (materials that can detonate when initiated or which can react explosively with water); **4** (materials that can detonate at normal temperatures or pressures).
NATIONAL FIRE PROTECTION ASSOCIATION: Health Hazard: **0** (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure causes death or major residual injury).

NATIONAL FIRE PROTECTION ASSOCIATION (Continued): Flammability Hazard and Reactivity Hazard: Refer to definitions for "Hazardous Materials Identification System".

FLAMMABILITY LIMITS IN AIR:
Much of the information related to fire and explosion is derived from the National Fire Protection Association (**NFPA**). Flash Point - Minimum temperature at which a liquid gives off sufficient vapors to form an ignitable mixture with air. Autoignition Temperature: The minimum temperature required to initiate combustion in air with no other source of ignition. LEL - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. UEL - the highest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source.

TOXICOLOGICAL INFORMATION:
Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms used in this section are: **LD_{50}** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC_{50}** - Lethal Concentration (gases) which kills 50% of the exposed animals; **ppm** concentration expressed in parts of material per million parts of air or water; **mg/m^3** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Data from several sources are used to evaluate the cancer-causing potential of the material. The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TDo**, **LDLo**, and **LDo**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **BEI** - Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV. Ecological Information: EC is the effect concentration in water.

REGULATORY INFORMATION:
This section explains the impact of various laws and regulations on the material. **EPA** is the U.S. Environmental Protection Agency. **WHMIS** is the Canadian Workplace Hazardous Materials Information System. **DOT** and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively. Superfund Amendments and Reauthorization Act **(SARA)**; the Canadian Domestic/Non-Domestic Substances List **(DSL/NDSL)**; the U.S. Toxic Substance Control Act **(TSCA)**; Marine Pollutant status according to the **DOT**; the Comprehensive Environmental Response, Compensation, and Liability Act **(CERCLA or Superfund)**; and various state regulations.