NVO-145

**DEFINITION PLAN
ALTERNATE REENTRY
AND TESTING**

MAY 1974

**U.S. ATOMIC ENERGY COMMISSION
CONTINENTAL OIL COMPANY**

MASTER

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REVISED SCHEDULE OF MAJOR ACTIVITIES

EXPECTED STARTING & COMPLETION DATES

OPERATION	MAY	JUNE		JULY	AUG	SEPT		OCT	NOV
	24	13	17	14		15	26	21	
I. SITE PREPARATION									
2. RIG UP									
3. RAD SAFE MOBILIZATION									
4. DRILL TO 2200' SET 10 3/4" CASING									
5. DRILL TO KOP									
6. DRILL TO 7" CASING PT. & SET 7" CASING. NIPPLE UP BOP's DWC & OTIS									
7. DRILL TO T.D. & SET 5" LINER									
8. NIPPLE UP-SHORT TEST & RIG DOWN									
9. PREPARE TO TEST FLOW TEST									
10. RESERVOIR BUILDUP									
II. SITE ROLLUP & DECONTAMINATION									

ITEM #6 IS THE CRITICAL
PATH. SUBSEQUENT OPER-
ATIONS WILL SLIP PROPOR-
TIONALLY AS #6 SLIPS.

Cont.

REVISED: AUGUST 13, 1974

PNE-RB-57

PROJECT RIO BLANCO - ALTERNATE REENTRY-RB-AR-2

REVISED SCHEDULE OF MAJOR ACTIVITIES

EXPECTED STARTING & COMPLETION DATES

OPERATION	MAY	JUNE		JULY	AUG	SEPT		OCT	NOV
	24	13	17	14		15	26	21	
I. SITE PREPARATION									
2. RIG UP									
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8. NIPPLE UP - SHORT TEST & RIG DOWN									
9. PREPARE TO TEST FLOW TEST									
10. RESERVOIR BUILDUP									
II. SITE ROLLUP & DECONTAMINATION									

ITEM #6 IS THE CRITICAL PATH. SUBSEQUENT OPERATIONS WILL SLIP PROPORTIONALLY AS #6 SLIPS.

Cont.

REVISED: AUGUST 13, 1974

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I. INTRODUCTION

A. Background

Project Rio Blanco was the first phase of a proposed multiphase program to determine the commercial development potential of a low-permeability natural gas field fractured by nuclear explosives. The RB-E-01 well is located in the Piceance Basin, Rio Blanco County, Colorado (see Figure I-A-1), and intersects gas-bearing, sandy shale sections too impermeable to produce gas by conventional methods.

Three 30-kt nuclear explosives suspended in the emplacement well at depths below ground level of 5,838, 6,230, and 6,689 feet, respectively, were all detonated simultaneously on May 17, 1973, in an attempt to fracture a vertical section approximately 1,300 feet high. The extent of fracturing in this section was expected to be several hundred feet in diameter.

Reentry drilling through the emplacement casing began nearly four months after the detonation, to allow short-lived radionuclides to decay. Crushed or displaced casing near the chimney necessitated whipstock drilling outside of, but parallel to, the emplacement well in order to connect with the fracture zone. Drilling was completed on October 12, 1973.

Following earlier calibration tests, drawdown testing began on November 14, and continued until November 20. Information from this test indicated that production characteristics were below expectations. A different rare gas tracer was emplaced with each explosive for the purpose of identifying gas from their respective zones. Only the top tracer was observed. Thus, it appeared that interconnection of the top chimney with the lower regions had not been accomplished.

High temperatures created some mechanical difficulties that required correction before extended flow testing could be continued. The operation of necessity went into standby status while equipment underwent modification. Testing was resumed on January 28, 1974, and continued until February 15, at which time the well was shut in. A total of 98 million cubic feet of dry chimney gas had been produced during both phases of testing.

The January-February phase of testing confirmed early indications that: (1) the chimneys do not appear to be connected, and (2) the stimulated reservoir, in communication with the top chimney, for unknown reasons, has a much lower flow capacity than expected. In order to completely evaluate the stimulation effects of the detonation and the reservoir, additional data are required. For this reason, an alternate reentry hole (RB-AR-2) will be drilled into the middle chimney on an angle from the Fawn Creek Government Number 1

FIG. I-A-1

Well pad about 1,200 feet to the southwest (see Figures I-A-2 and I-A-3). Participating in this effort will be the Continental Oil Company (CONOCO), the U.S. Atomic Energy Commission (AEC), the Lawrence Livermore Laboratory (LLL), the Equity Oil Company (Equity), EG&G, Inc., (EG&G), and CER Geonuclear Corporation (CER).

B. Program Objectives

This Project Definition modifies the reentry program described in Project Rio Blanco Definition Plan, Vol. III, Reentry-Related Detailed Tasks, January, 1973 (PDP Vol. III), and will describe the drilling, production testing, formation sampling safety, security, and environmental programs, as well as the project management aspects of the alternate reentry project. The Plan is, however, subject to modification as dictated by circumstances encountered during the field activity.

Drilling will be accomplished in two phases. The first phase will be the drilling and casing of a 2,200-foot vertical hole. The second phase will extend the hole to approximately 4,700 feet where it will be directionally drilled toward the detonation point of the middle chimney in RB-E-01. The hole will intersect the chimney at about 60° from the vertical, and be used for drawdown testing and the gathering of data that should define chimney characteristics. Subsequently, a second drawdown test will be conducted in the same hole in Ft. Union sands outside of the fracture region created by the uppermost explosion. These data will assist scientists and engineers in interpreting detonation-related phenomena with respect to low productivity observed during the drawdown testing of the upper chimney.

The major technical objectives of this program are several: (1) to evaluate the stimulation of the tight gas sands in connection with the second nuclear chimney and possibly the bottom chimney; (2) determine the chimney, fracture, and formation characteristics from flow test and pressure buildup data; (3) investigate the radial extent of fracturing while drilling; (4) investigate the chemistry and radiochemistry of the produced gas; (5) determine detonation-related geometry of the middle chimney such as chimney and cavity radius; any mineralogical changes in the rock properties; fracture distribution as deduced from studies of micro- and macrofractures; distribution of melt and the HTO content of melt samples if economically and technically feasible; (this information will be determined from drilling, logging, and possibly core sampling. The acquisition of this information will depend on the drilling and hole condition encountered while drilling); and (6) determine the flow capacity (kh) of the Ft. Union zones opposite the top chimney, but far enough away from the detonation point that the flow capacity should not have been altered from the detonation.

SW 1/4 NW 1/4, SECTION 14
T3S, R 98 W, 6 TH P.M.

FIG. I-A-2 LOCATION MAP

FIG. I-A-3 RB-AR-2 DIRECTIONAL CONFIGURATION

II. GENERALIZED SITE ACTIVITIES

A. Site Preparation

Drilling will take place on the Fawn Creek Government Number 1 Well pad approximately 1,200 feet southwest of RB-E-01. The Fawn Creek pad is level but will be further dressed as necessary to accommodate reentry activities.

1. Trailers

Trailers will be provided for the LLL/AEC and CONOCO. The radiological protection trailers will be government furnished through the Radiological Support Contractor, Eberline Instrument Corporation (EIC), under contract to CER, and maintained on the RB-E-01 pad with the exception of the EIC access control trailer which will be located on the north end of the RB-AR-2 pad. CONOCO, through its contractor, CER, will furnish its monitoring system for radiological effluent documentation (i.e., TRY-KRY System) installed in a trailer on the RB-E-01 pad. Personnel trailers will remain at the RB-E-01 pad. An LLL transportainer will also be located on the RB-AR-2 pad within the surrounding fence. This transportainer will be capable of locked, temporary storage of any classified material brought out of the RB-AR-2 Well during drilling.

2. Fencing

The flare stack is located in the clearing to the northwest and above the RB-E-01 pad. The area, including the flare stack, storage and condensate tanks, separator, and wellhead equipment is fenced with two-strand barbed wire to prevent livestock from entering the area.

B. Power Installation

The White River Electric Company has a power line to the RB-E-01 site. Reynolds Electric and Engineering Co., Inc. (REEC) will contract with the power company to extend the power line to the RB-AR-2 site.

C. Communications

Telephone and radio communications will be available at the RB-AR-2 project.

1. Telephones

The telephone system to be used will be the CER microwave system identified in detail in Project Rio Blanco Definition Plan,

Vol. II, Detonation-Related Detailed Tasks, January, 1973
(PDP Vol. II). Two telephone lines will be extended from their existing RB-E-01 location to the RB-AR-2 site. These lines will be at the following locations:

Telephone No. 1 EIC (access control trailer)

Telephone No. 2 Rig (tool pushers trailer)

2. Radios

One radio net will be available to all of the project participants. A base station located at the RB-E-01 and a mobile unit in a CONOCO vehicle will be available for use by AEC/LLL, EIC, and CONOCO/CER personnel. The radio system will connect the RB-AR-2/RB-E-01 sites to the CONOCO Grand Junction office. The frequencies of the radio net will be 153.350 MHZ for repeat transmit and 158.370 MHZ for repeat receive. These frequencies correspond to Net 2, as described in the PDP Vol. II.

D. Vehicles

Project participants will be responsible for providing and maintaining their own vehicles.

E. General Operational and Logistics Support

REECo will provide the following general logistical and operational support:

1. Miscellaneous Buckslip Items.
2. Crafts.
3. Clerical (if necessary).
4. Drayage.
5. Sanitary Facilities.

F. Occupational Health and Safety

1. General

All operations and activities will be conducted in accordance with the standards of the Occupational Safety and Health Act of 1970 (OSHA).

All participating organizations are responsible for the health and safety of their own personnel and for conducting all activities in accordance with procedures that assure:

- a. A safe and healthful environment for the employees.
- b. Control and minimization of hazards to the public and to personnel of other participants.
- c. Minimization of the accidental damage or loss of equipment, materials, and property.

2. First Aid

REECO will provide each participating agency contacts with local medical facilities and physicians in the Grand Junction, Rifle, and Meeker areas for use in the event of accident or illness. Emergency transportation of injured persons of all agencies to a medical facility will be provided.

REECO will arrange for and provide first aid supplies as approved by a physician.

3. Fire Protection

Hand-operated fire extinguishers will be provided at the well locations at points convenient to each significant structure or piece of equipment. Extinguisher types will be varied for control of Class A, B, or C fires, as appropriate.

4. Sanitation

REECO will provide potable water for drinking and cooking. Chemical or standard toilets will be provided and serviced as required. Solid wastes will be disposed of in accordance with local regulations.

A limited number of trailers at the RB-E-01 well location will be connected to a nonpotable water source and sewage system involving a septic tank. This will be in accordance with Rio Blanco County Planning Directive.

III. REENTRY OPERATIONS

A. Drilling Operations

1. Phase I--Hole Characteristics and Drilling Plan-Vertical Hole (0-2,200 feet)

A 30-inch hole will be drilled to a depth of approximately 20 feet and 24-inch OD conductor pipe will be set and cemented to the surface.

A 22-inch hole will be drilled to a depth of 150 feet and surface casing (16-inch OD) will be run to a 150-foot depth and cemented to the surface. A 15-inch hole will then be drilled from 150 feet to approximately 2,200 feet total depth (TD). The intermediate casing (10 3/4-inch OD) will be run to 2,200 feet and cemented back to surface. A pressure test will be performed on the intermediate casing and wellhead.

2. Estimated Formation Tops

All drilling, casing and any other depth measurements will be referenced to the kelly bushing. Logging and formation tops will be referenced to ground level.

<u>Formation</u>	<u>Top in True Vertical Depth (ft)</u>	<u>Elevation from Mean Sea Level (ft)</u>
Alluvium	Surface	+ 6,622
Green River	125	+ 6,497
Parachute Creek Member	125	+ 6,497
Mahogany Marker	780	+ 5,842
Black Marker	910	+ 5,712
Orange Marker	2,130	+ 4,492
Piceance Creek Sand	2,280	+ 4,342
Wasatch	2,830	+ 3,792
Fort Union Sand	5,460	+ 1,162
Mesaverde	6,090	+ 532
TD	about 6,250	+ 372

3. Drilling Procedure

- a. Use dry hole digger to drill hole for 24-inch conductor pipe. Cement conductor pipe from 20 feet TD to surface.
- b. Build wooden cellar, 8 feet wide, 12 feet long, and 9 feet deep. Line with steel.
- c. Move in drilling rig and rig up. Concurrently install the Contaminated Water Containment System (see Section V). This

system will be similar to the one used for RB-E-01 reentry, and its installation will have the concurrence of the LLL Operations Director.

- d. Drill 12 1/4-inch hole to 150 feet, open 12 1/4-inch hole to 22 inches.
- e. Run 150 feet of 16-inch H-40 casing, guide shoe on bottom and baffle collar one joint up from bottom. Cement to surface. Wait on cement (WOC) 18 hours. Use slurry A (RFC cement), see Table III-A-1.
- f. Install 16-inch casing head, 16-inch hydraulic BOP, and 16-inch Hydril BOP or double gate BOP. Install kill line and flowline.
- g. Pressure test BOPs and casing with 400-psig surface pressure.
- h. Drill plug, cement, shoe, and formation with 15-inch bit. Use a centralized and stabilized assembly for drilling the 15-inch hole.
- i. Drill the 15-inch hole to 2,200 feet. Obtain deviation survey every trip or at least every 500 feet.
- j. Run integrated caliper survey from 2,200 feet to 150 feet for cementing purposes.
- k. Run 10 3/4-inch casing to 2,200 feet with float shoe, float collar, and stage collar. Use centralizers throughout the string. Install slips in head before cementing. (Ten joints of the 10 3/4-inch casing to be sandblasted.)
- l. Cement first stage. Use slurry B (see Table III-A-1). Bump plug on float collar. Test that float equipment is holding properly. Drop stage collar opening bomb. Open stage collar, and circulate out cement above tool. Wait 12 hours for cement to set. Cement second stage to surface using slurry C (see Table III-A-1).
- m. Unbolt flange on 16-inch casing head. Remove BOPs and cut off 10 3/4-inch casing.
- n. Install 16-inch x 10-inch Series 1500 wellhead and test connection.
- o. Install 10-inch Series 900 or 1500 double gate BOP with blind and pipe rams and 10-inch Series 900 or 1500 Hydril and test to 3000 psi.
- p. Drill out stage collar and clean out to top of float collar (approximately 2,170 feet).

TABLE III-A-1

CEMENT SYSTEMS AND VOLUMES REQUIRED

<u>Slurry</u>	<u>Purpose</u>	<u>System</u>	<u>Yield ft³/sack</u>	<u>Density lbs/gal</u>	<u>Volume Req'd Incl. Excess ft³</u>	<u>Pumping Time Hrs:Min</u>	<u>Compressive Strength psi</u>
A	Surface casing 150' to surface 22" hole--16" casing	Class G 10% D-53 2% CaCl ₂	1.6	14.2	373	3:10	500 psi in 8 hours @ 80° F
B	Intermediate casing, 1st stage 2,200' to ~1,200'	Class G 20% silica sand, retarder as necessary 12% gel, 114% H ₂ O	2.39	13.0	Will be based on caliper survey	<3:00	To be deter- mined @ 100°
C	Intermediate casing, 2nd stage	Class G 20% silica sand, 12% Gel, 114% H ₂ O	2.39	13.0	Will be based on caliper survey	<3:00	To be deter- mined @ 80°

- q. Pressure-test stage collar and 10 3/4-inch casing with 500-psig surface pressure.
- r. Run cement bond log (CBL) from surface to 2,200 feet. Run gyroscopic direction survey with 50-foot stations from surface to TD, both going in and coming out of the hole.

4. Surface Equipment and Services

a. Wellhead

The starting head 16-inch x 10 3/4-inch will be Series 900. The remaining wellhead will be Series 1500 (5,000-psi working pressure, 10,000-psi test pressure).

b. Blowout Preventer (BOP) Equipment

A 16-inch hydraulic double-gate Series 900 BOP or a single gate BOP with a 16-inch Hydril will be used on the well. Series 600 BOPs are acceptable if an adapter flange for the Series 900 wellhead flange is provided.

5. Downhole Equipment and Services

a. Surface Casing

All casing and downhole equipment will be measured on the rack before running in the hole. Sixteen-inch OD, H-40, 65-lb/ft casing will be set at 150 feet. Thread-locking compound will be used on the guide shoe and the baffle collar located one joint above the shoe.

b. Intermediate Casing

The intermediate casing will consist of 10 3/4-inch OD, Range 3 casing as listed below:

<u>Depth (ft)</u>	<u>Lb/ft</u>	<u>Grade</u>	<u>Joint</u>	<u>ID (in.)</u>	
				<u>Actual</u>	<u>Drift</u>
Surface to 2,200 feet	45.5	P-110	Buttress	9.950	9.794

c. Centralizers

(1) Surface Casing

A centralizer will be placed approximately 20 feet above the guide shoe and then on every collar to the surface.

(2) Intermediate Casing

Centralizers will be placed at approximately 15 feet above the shoe and on every third casing collar to surface.

d. Float and Guide Equipment

(1) Surface Casing

A guide shoe will be installed on the bottom joint, and a baffle collar will be located approximately 30 feet (one joint) above the guide shoe.

(2) Intermediate Casing

A float shoe will be installed on the bottom joint, and a float collar will be located approximately 45 feet (one joint) above the shoe. A stage cementing collar will be positioned in the 10 3/4-inch string based on drilling conditions and hole caliper log.

e. Drilling Fluid

From surface to 2,200 feet, mud density will be held at 9.0 to 9.5 lb/gal with viscosity below 50 sec/qt. Viscosity will be raised as hole conditions dictate. Drilling fluid water loss will be maintained at approximately 10 ml API. A de-sander and shale shaker will be used to reduce solids in the system. Gel, barites, and lost circulation material will be added as the situation requires. A daily sample of drilling fluid will be obtained and stored at the site.

f. Drill Cuttings

Sample cuttings at 30-foot intervals will be obtained from the surface to TD. The samples will be washed in water, placed in conventional sample bags, and stored at the rig during the drilling operation. (When radiological controls are instituted, this will be done in the manner prescribed by EIC.)

g. Cores

None planned.

h. Drill Stem Tests

None planned.

i. Logging Program

All logging depths will be relative to ground level (6,622.5 feet).

(1) 15-Inch Open Hole

Integrated Caliper Survey
(capable of recording up to
a 36-inch diameter, minimum
of 3 arms)

Surface to 2,200 feet

(2) 10 3/4-Inch Cased Hole

Cement Bond Log	Surface to 2,200 feet
Gyroscopic Directional Survey (with 50-foot stations, in and out with maximum variance of 10 feet)	Surface to 2,200 feet

j. Deviation Control

Stabilizers will be used, if necessary, while drilling 15-inch hole.

6. Cementing Operations

The physical properties and volume required for the cement systems to be used on the well are given in Table III-A-1. Some modification to cement systems will be made, if required, to achieve desired properties of a specific cement batch.

a. Surface Casing

The volume for cementing the surface casing includes 100 percent excess to ensure circulating cement back to the surface.

b. Intermediate Casing

(1) First Stage

The 10 3/4-inch casing will be cemented in two stages. Mud flush will be pumped ahead of the first stage to displace the mud. The stage collar at about 1,200 feet will be opened and any cement above the collar circulated out.

(2) Second Stage

After waiting 12 hours for cement to set, the upper portion of the 10 3/4-inch casing will be cemented to the surface through the stage collar.

c. Testing

Thickening time and compressive strength tests will be run on samples of the cement to be used just prior to the actual cementing operation.

7. Phase II--Hole Characteristic and Drilling Plan--Directional Hole (below 2,200 feet)

A 9 7/8-inch hole will be drilled, near vertical, to a depth of approximately 4,700 feet and then be directionally controlled

toward the middle chimney region of the RB-E-01 well. The MD (measured depth) of the 9 7/8-inch hole will be approximately 6,400 feet. Logging will be accomplished (see logging program), if possible, prior to running 7-inch casing in the hole. After the 7-inch casing is cemented, the 10-inch Series 900 or 1500 blowout preventer stack will be removed and the 6-inch Series 1500 tubing head added to the wellhead. Six-inch Series 1500 blowout and snubbing preventers will be utilized until the well is completed. A balanced drilling fluid column system will be used for drilling or coring from 6,400 feet MD to approximately 6,800 feet MD, the interval where it is expected the lost circulation zones will be encountered. The balanced system should help reduce the loss of fluid into the fractures and cavity regions. A drilling well control (DWC) unit will be used to separate gas from the mud system.

Hole size from approximately 6,400 feet to approximately 6,800 feet will be 6 1/4-inches. After reaching total depth (TD), a 5-inch flush joint liner will be run into the hole and hung in the 7-inch casing. No cement will be placed behind the liner. Logging will be accomplished and then 2 7/8-inch tubing will be run to near the top of the 5-inch liner hanger. Plugs will be used in the 2 7/8-inch tubing as a safety precaution for additional control of the well. After the tubing hanger is landed in the tubing head with downhole plugs installed in the tubing, the 6-inch blowout preventer stack will be removed and the remainder of the wellhead will be installed and tested. Two master valves will be used on the tubing head. Plugs will be pulled by wireline through a lubricator under nitrogen pressure. After the plugs are pulled, the 5-inch flush joint liner will be perforated using a through-tubing perforating gun.

A short-term flow test will be run through the DWC prior to releasing rig to confirm communication with the second chimney.

8. Drilling Procedure Below 10 3/4-Inch Casing Depth

- a. Drill out float collar, stage collar, and formation using 9 7/8-inch bit.
- b. Drill vertical 9 7/8-inch hole. Survey at about 4,500 feet.
- c. Drill 9 7/8-inch hole to kickout point of approximately 4,700 feet.
- d. Directionally control 9 7/8-inch hole to approximately 6,400 feet MD or approximately 6,020 feet true vertical depth (TVD). Final drilling angle will be approximately 60° from the vertical. Directional surveys (utilizing eye tool or similar system) will be run as required. (Exact

true vertical depths and measured depths of 7-inch casing point will depend on directional hole and will be recalculated for actual conditions. The depths given here are only approximations).

- e. Run open hole logs, if possible. (See logging program.)
- f. Run 7-inch casing and cement first stage. Use slurry A (see Table III-A-2). Open stage collar and circulate. WOC approximately 18 hours. Set slips and pull 100,000 pounds over 7-inch casing weight. Cement second stage to surface and WOC, using slurry B (see Table III-A-2).
- g. Cut off 7-inch casing above slips. Remove 10-inch BOP equipment.
- h. Install 10-inch x 6-inch Series 1500 tubing head and pressure test.

9. Drilling Procedure Below 7-Inch Casing Depth

- a. Install drilling stack and pressure test individual components to 3,000 psi. Ensure that BOP controls on rig floor and remote control functions correctly.
- b. Pressure test the 7-inch casing to 3,000 psi.
- c. Install and hook up the DWC unit. The DWC unit representative will demonstrate the correct functioning and operation of the unit. Check out operation of snubbing BOPs and related hydraulic valves.
- d. Test operation of flareline, stack, and purge system using gas from Fawn Creek Government Number 1 Well.
- e. Ensure correct operation of recording instruments and alarms related to the drilling liquids systems after pits are at working levels.
- f. Check functioning of explosimeter system to ensure their correct operation and that alarms are working.
- g. Ensure that all personnel, equipment, spare parts, and equipment related to reentry are on location and ready.
- h. Run a 6 1/4-inch bit for drilling and 5-inch drill collars with a float and a plug receiving nipple immediately above the float. Drill pipe and drill collars should be magnaflux inspected prior to the start of the operation.
- i. Drill stage collar using water.

TABLE III-A-2

CEMENT SYSTEMS AND VOLUMES REQUIRED

<u>Slurry</u>	<u>Purpose</u>	<u>System</u>	<u>Yield ft³/sack</u>	<u>Density lbs/gal</u>	<u>Volume Req'd Incl. Excess ft³</u>	<u>Pumping Time</u>	<u>Compressive Strength</u>
A	Cementing from 7" casing shoe to the stage collar	Class G, 35% silica sand, 10% salt, and retarder	1.55	15.8	Will be based on caliper survey	*	*
B	Cement from 7" stud collar to the surface	Class G, 35% silica sand, 10% salt	1.55	15.8	Will be based on caliper survey	*	*

*To be determined.

- j. Mix 400 bbls minimum visbestos mud for standby system. If balance-water system will not contain formation gas owing to excessive lost circulation, the visbestos mud will be used to maintain control of the well. Run directional survey of hole before drilling out of shoe.
- k. Drill out shoe joint and approximately 100 feet of formation. If partial lost circulation occurs prior to this point, spot pill of mud with lost circulation material (LCM) and trip for new 6 1/4-inch bit. Run deviation survey prior to pulling out of hole. This step and all subsequent steps will be modified if a coring program is agreed upon.
- l. Run in hole with sidewall sampling tool and new bit.
- m. Drill ahead until decision is made to stop drilling and/or entry into chimney is achieved, and run liner.
- n. Run high-intensity gamma ray log through drill string. Obtain sidewall samples as required.
- o. Run wireline plug into drill pipe and set in plug receiving nipple. Pull out of hole keeping fluid column balanced, if possible. Every effort will be made to minimize fluid loss. Snub out of hole, if necessary. (Snubbing equipment and crew will be on the drill site before drilling out from 7-inch casing.)
- p. Run 5-inch flush joint liner and hang liner inside of 7-inch casing with approximately 50 feet of overlap.
- q. Run logs. Run temperature survey first to ensure that temperature limits of other logging sondes will not be exceeded.
- r. Run tubing. Land above liner.
- s. Nipple up wellhead. Install lubricator.
- t. Perforate liner and run short production test through DWC unit.
- u. If good communications are established, release rig.

10. Surface Equipment and Services

a. Wellhead

The wellhead components added for drilling and for final completion for flow testing will be Series 1500 (5,000-psi working pressure, 10,000-psi test pressure).

Figure III-A-1 shows the complete wellhead.

b. Containment Equipment

The containment equipment or drilling stack employed during reentry drilling operations is shown on Figure III-A-2. The stack sits on top of the tubing head during the drilling of the 6 1/4-inch hole. All equipment utilized will be Series 1500 (5,000-psi working pressure, 10,000-psi test pressure), with the exception of the rotating head which is a rubber-type packoff around the drill pipe and is used to direct any small quantities of gas returned with the drilling fluid to the pits during normal drilling operations. Any larger quantities of gas will be diverted through the DWC unit by use of the Hydril or 3 1/2-inch stripping ram BOP above the circulation spool.

All individual units of the preventer stack will be shop tested to rated working pressures of 5,000 psi. Field tests of the BOP stack will be conducted to 3,000 psi which exceeds the expected surface pressure by approximately 500 psi. Because presently available BOP equipment is not capable of withstanding a high-temperature environment over extended periods, flow testing will not be run through the BOP stack. Field tests will be conducted by installing the blank tubing hanger plug in the wellhead with either 3 1/2-inch internal flush (IF) drill pipe, or 4 3/4-inch OD drill collars, and pressuring above this plug with liquid to test the individual rams of the BOP equipment. Functional tests of the Hydril to 500 psi will also be conducted.

Sizes and types of rams have been selected to cover operations in and out of the hole during all of the drilling phases, including snubbing operations during the drilling of the 6 1/4-inch hole.

Dual controls for the various BOP units will be used. One set will be on the rig floor, and one set will be remotely located.

c. Drilling Rig

The rig selected will be sized to safely and efficiently handle the downhole operations. Substructure height must be at least 17 feet to give clearance for the necessary drilling stack components required for drilling and snubbing operations. A general layout of the rig is shown in Figure III-A-3.

FIG. III-A-1 RB-AR-2 WELLHEAD STATUS

**FIG. III-A-2 BLOWOUT PREVENTOR STACK
RB-AR-2**

FIG. III-A-3
CONOCO—U. S. AEC PROPOSED WELL
LOCATION LAYOUT FOR DRILLING &
COMPLETION OF WELL RB-AR-2

d. Drilling Recording Instruments

Instruments and recorders will be utilized in conjunction with reentry operations to give the following information:

- (1) Pit volume indicators with alarms to determine changes in mud volume.
- (2) Drilling time, depth, penetration rate, RPM, and hook load will be recorded.
- (3) Flow sensor on mud return flowline.

e. Snubbing Equipment

Reference PDP, Vol. III, Sec. III-2-e, pages 29-32.

f. Drilling Well Control (DWC)

Reference PDP, Vol. III, Sec. III-2-f, pages 32-35.

g. Explosimeter System

Reference PDP, Vol. III, Sec. III-2-g, page 35.

h. Flareline Stack and Purge System

Reference PDP, Vol. III, Sec. III-2-h, pages 35-37.

11. Downhole Equipment and Services

a. Casing and Tubing

Casing specifications:

(1) 16-Inch Surface Pipe

Size OD	16.00 in.
Wt./ft.	65 lbs./ft.
Grade	H-40
ID	15.250 in.
Drift ID	15.062 in.
Collar OD	17.00 in.
Burst strength	1,640 psi
Collapse strength	670 psi
Tensile strength	439,000 lbs.
Type connection	ST&C

(2) 10 3/4-Inch Intermediate String

Size OD	10.75 in.
Wt./ft.	45.5 lbs./ft.
Grade	P-110
ID	9.950 in.
Drift ID	9.794 in.
Collar OD	11.750 in.
Burst strength	6,600 psi
Collapse strength	2,610 psi
Tensile strength	1,400,000 lbs.
Type connection	Buttress

(3) 7-Inch Primary Casing

Size OD	7.0 in.
Wt./ft.	23 lb./ft.
Grade	CYS-95
ID	6.366 in.
Drift ID	6.241 in.
Collar OD	7.656 in.
Burst strength	7,530 psi
Collapse strength	4,150 psi
Tensile strength	636,000 lbs.
Type connection	Buttress

(4) 5-Inch FJ Liner

Size OD	5 in.
Wt./ft.	14.78 lbs./ft.
Grade	J-55
ID	4.408 in.
Tensile strength	228,000 lbs.
Type connection	Atlas Bradford Quadraseal (FL-4S)

- (5) Tubing: 2 7/8-Inch. EUE tubing will be used inside the 7-inch casing for an instrument string and for injecting chemicals downhole for corrosion protection of the 7-inch casing during flow.

Size OD	2.875 in.
Wt./ft. with coupling	6.50 lbs.
Grade	J-55
Drift diameter	2.347 in.
Coupling OD	3.668 in.
Collapse resistance	6,800 psi
Internal yield pressure	7,260 psi
Joint yield strength	99,660 lbs.

b. Drill Pipe and Drill Collars

Contractor-furnished except for 6 1/4-inch hole.

The drill string used for reentry below the 7-inch casing will be 3 1/2-inch IF drill pipe with 18° taper on the shoulders. The pipe will be magnaflux inspected prior to running in the hole.

The drill collars (provided by the AEC) will be approximately 4 3/4-inch OD. Special internal bored drill collars are needed to accommodate the sidewall sampling tool.

The drill string will also include a float and plug nipples above the float collar to receive retrievable wire-line plugs run inside of the drill string. The drill collars will be magnafluxed prior to running into the hole.

c. Sidewall Samples

This program will be subject to modification based on the coring program. However, if no cores are taken, approximately 12 sidewall samples may be taken based on the data obtained during drilling and from gamma ray logs run through the drill pipe. If the coring program is implemented, a few sidewall samples may also be required to supplement the coring program.

d. Coring

Core samples from the fracture region of the detonation are desired. The project Participants agree to jointly evaluate, to the best of their ability, possible ways to obtain such core. This evaluation will include possible continuous coring methods and consider costs, risks, and chance of success. Such an evaluation shall have been completed before the 7-inch casing point is reached. If continuous coring is deemed infeasible, obtaining two or three conventional cores will be evaluated. It is recognized that hole conditions below the 7-inch casing may shorten or eliminate any attempts at coring.

e. Downhole Drilling Motor

A Dyna Drill will be used for only the directional portion of the hole.

f. Drilling Fluids

(1) A low solids mud system will be used to drill the 9 7/8-inch hole. Mud density will be maintained at approximately

9.0 pounds per gallon. Viscosity will be held to approximately 40-50 seconds unless hole conditions indicate higher viscosity is required. Water loss will be at approximately 10ml API.

- (2) Water will be used to drill the 6 1/4-inch hole below the 7-inch casing point. A balanced system will be used to prevent the influx of fluids into the wellbore upon the first indication of loss of returns. Minimum rates will be utilized to keep water losses to the cavity at a minimum.
- (3) A visbestos mud system will be mixed and on standby during drilling of the 6 1/4-inch hole, if it appears that the well cannot be controlled with water only.

12. Logging Program

a. 9 7/8-Inch Open Hole

	<u>Logging Depth</u>
1. Dual Induction Laterolog--8	TD to 5,200'
2. Compensated Neutron Porosity	TD to 5,200'
3. Compensated Formation Density	TD to 5,200'
4. Compensated Sonic With Variable Density Trace	TD to 5,200'

b. 7-Inch Cased Hole

1. Cement Bond Log	TD to surface
2. Gamma Ray Neutron w/Casing Collar Locator	TD to 5,200'
3. Directional Survey	

c. 5-Inch Flush Joint Liner

1. Temperature Survey	Thru liner
2. High-Intensity Gamma Ray	Thru liner
3. Gamma-Gamma Density	Thru liner
4. Neutron Log	Thru liner

13. Drill Cutting Samples

From 2,200 feet to 5,000 feet, single samples every 30 feet will be sufficient.

From 5,000 feet to 7-inch casing point, duplicate cutting samples will be required every 10 feet.

Below the 7-inch casing point, samples will be obtained every five feet or as specified by LLL until such time as circulation is lost. See Chapter V, Radiological Controls.

IV. PRODUCTION TESTING

A. General

The production testing will consist of: (1) a flow period to measure the pressure depletion in the chimney to determine the chimney volume and effective fracture volume, and (2) a long-term pressure buildup to determine the extent of fracturing and the virgin reservoir characteristics.

Gas samples will be taken during the flow testing and analyzed by LLL to determine the amount and type of radioactive species present in the produced gas. Compositional analysis will also be run on the samples to determine the BTU content and chemical composition of the gas being produced. Trace analysis for certain rare gases will be used to determine if communication between the chimneys has been achieved. Sample containers will be provided by the analyzing agency.

B. Site Layout

Figures IV-B-1 and IV-B-2 show the schematic flow diagram of all major production test equipment. All of the pressure and temperature recorders, the wellhead control equipment, separator, monitors, and liquid storage vessels will be located at the RB-E-01 site. The instrument supply gas, purge gas, and pilot light gas will be supplied from the Fawn Creek Government Number 1 Well.

C. Equipment

The gas will be produced from the 7-inch casing through the wing valve to the high-pressure separator. The liquids will be removed at the high-pressure separator and further separated into water and hydrocarbons. Liquids will then be measured and stored for later disposal. After passing through the separator, the gas flow rate will be measured at a flow prover and the gas burned from the flare stack. If freezing weather conditions are anticipated during production testing, equipment design will include features to prevent water freezing in lines and tanks.

1. Wellhead

Figure IV-C-1 shows the wellhead with the wireline lubricator and control head. The ESDV-1 valve shown in the drawing is the emergency shutdown valve and will be activated by any one of several critical conditions. These are listed in Section IV-E.

2. Fin Fan Coolers

Three fin fan coolers are hooked up in parallel to cool the incoming gas stream in order to separate more efficiently the produced water from the gas stream and to reduce the temperature

FIG. IV-B-1
PROJECT RIO BLANCO
PRODUCTION TEST SYSTEM

FIG. IV-B-2
PROJECT RIO BLANCO
LIQUID STORAGE &
DISPOSAL SYSTEMS

FIG. IV-C-1 RB-AR-2 WELLHEAD & LUBRICATOR FOR PRODUCTION TESTING

of the fluid stream. The total calculated cooling capacity of the three coolers is 10 million BTUs/hour.

3. Separator

Reference PDP, Vol. III, Section IV-C-2, page 55.

4. Flow Rate Prover

Downstream of the manual choke will be a short section of line containing sampling ports for the chemical and radiochemical monitoring. The gas flow rate will be measured using critical-flow provers. When the flow rate reaches sonic velocity through the prover, it becomes independent of downstream pressure. Constant rate can be maintained by controlling the upstream pressure. Therefore, corrections for changes in temperature and gas gravity will be made in the upstream pressure to keep the rate constant.

5. Flare Stack

During the flow test, the gas produced from the chimney will be measured and then burned. The hydrocarbon condensate will be injected into the flare stream and burned with the gas.

6. Storage Vessels

a. Water Storage

The produced water will be stored in the four 400-bbl tanks. The tanks will be piped in parallel with a common overflow connection at the top. Produced water will be sampled for radioactivity before disposal.

b. Condensate Storage

Two 1,000-gallon, low-pressure storage vessels will be used to store the condensate until disposal. The tanks are 125-psi working-pressure vessels with a common overflow connection between them. Produced condensate will be sampled for radioactivity before disposal.

7. Instrumentation

The wellhead flowing pressure and temperature and static tubing pressure will be recorded. The upstream and downstream pressures at the flow prover, flowing temperatures, and gas gravity will also be measured and recorded. The bottom-hole pressure and temperature will be measured using Amerada downhole instruments during the first two weeks of the shut-in pressure buildup period. After the first two weeks, the bottom-hole pressure will be recorded using a Sperry Sun surface recording instrument.

Amerada downhole instruments will replace the Sperry Sun the last week of shut-in pressure buildup. The instruments will be calibrated prior to installation and at the conclusion of testing unless more frequent calibrations are needed.

D. Test Schedule

1. Flow Rate and Duration

The test schedule is designed for one flow period followed by a long-term buildup. The test design is for a 10- to 15-day flow period at a constant rate of about 8 to 10 MMSCFD. The production test may be shortened or lengthened if the bottom-hole pressure response indicates that some modification is required. If the pressure response is close to the expected pressure behavior, the 10- to 15-day flow period should be sufficient. A 25 to 40 percent pressure reduction of the initial chimney pressure is desired.

2. Buildup

It is anticipated that a 60- to 90-day buildup period will be required.

3. Data Reporting

A daily summary report similar to the one made during January-February testing on RB-E-01 will be used to provide information to the project participants on a daily basis.

E. Automation and Alarm Systems

The test equipment will be equipped with safety features wired to a remote indicating panel located in the alarm and control building to ensure adequate control and monitoring of the operation. These features are separated into two classes: those to shut down the operation, and those which require local corrective action. All of the functions requiring a shutdown actuate the high/low-pressure valve located at the wellhead and the secondary shut-in valve at the separator. Table IV-E-1 outlines the alarm features and the functions that each system will actuate.

1. Flare Stack Pilot Ignition System

The pilot lights will be ignited using an electrical arcing system. If the pilot lights go out and cannot be reignited, a warning light will be energized on the alarm and control panel.

2. Storage Tanks

The tanks will be equipped with high-liquid-level warning light indicators (HL-1 through HL-6) to show when a tank is almost

TABLE IV-E-1. OUTLINE OF ALARM AND CONTROL FUNCTIONS.

<u>Alarm</u>	<u>Function</u>	<u>System Activated</u>				
		ESDV-1	SDV-2	MC-1	MC-2	Panel Lite
H/LP-1	High- & Low-Pressure Alarm--Wellhead	X	X	X	X	X
H/LP-2	High- & Low-Pressure Alarm--Separator	X	X	X	X	X
Remote Shutdown	Shutdown Switch	X	X	X	X	X
Panel Shutdown	Shutdown Switch	X	X	X	X	X
FS-1	Flow Switch--Bypass Separator	X	X	X	X	X
HLL-1	All Water Tanks Full	X	X	X	X	X
HLL-2	All Condensate Tanks	X	X	X	X	X
HL-1 thru 4	High Tank Level, Water Tanks					X
HL-5 & HL-6	High Tank Level, Condensate Tanks					X
LL-1 thru 4	Low-Level Alarm, Water Tanks			X		X
LL-5 & LL-6	Low-Level Alarm, Condensate Tanks				X	X
FF-1	Flame Failure--Flare Stack Pilot Light					X
H/LP-3	High- & Low-Pressure Alarm Water Disposal System			X		X

<u>System Designation</u>	<u>Location</u>
ESDV-1--Emergency shutdown valve	On flow line at wellhead
SDV-2--Shutdown valve	On flow line at separator
MC-1--Motor controller	On water disposal pump
MC-2--Motor controller	On condensate disposal pump

full and flow should be changed to another tank. Both the hydrocarbon and water tanks will have a high-liquid-level switch. This float switch will be located above the overflow connect line between tanks. If, for any reason, the tanks fill to the level of the float switch, indicating all the tanks are full, the switch (HLL-1 or HLL-2) will actuate an alarm on the control panel and also shut in the test to prevent spilling. Low-liquid-level pump shutdown switches (LL-1 through LL-6) will be installed on all tanks to prevent operation of the disposal pump when the tank is empty. This switch will also light an alarm on the control panel.

3. Separator

The separator will be equipped with three alarm and shutdown features (Figure IV-E-1).

- a. A flow switch (FS-1) on the pressure relief line will shut the well in and signal the alarm panel if the rupture disc should "pop" and flow is bypassing the separator.
- b. A high-pressure switch (H/LP-2) will also shut in the well and signal the alarm panel if the downstream flow should be shut off due to freeze up or if the choke valve downstream of the separator is closed during the flow testing.
- c. The low-pressure switch (H/LP-2) will also shut in the well and signal the alarm panel if a line in the system ruptures.

4. Wellhead

A high-/low-pressure switch (H/LP-1) will be located on the wellhead to shut in the well automatically if the pressures should exceed the preset limits. The preset limits will be based on the operating conditions during flow. The lower limit will be set to shut in the well in the event of a line rupture downstream. A high-pressure shut-in seems remote, but if for some reason the wellhead pressure should build above the preset limits, the well will shut in to protect the lines downstream from being overpressured. The upper limit will be set at or below the rated working pressure of the wellhead equipment and flow line to the separator.

5. Water Disposal Pump

A high-/low-pressure switch (H/LP-3) will be located at the water disposal pump (see Figure IV-E-1). If the pressures should exceed the preset limits, the injection pump will be shutdown and a signal sent to the alarm and control panel. This high-pressure limit switch protects the wellhead and downhole equipment from being over-pressured should the pressure limit switch at the

FIG. IV-E-1 SCHEMATIC OF THE SHUTDOWN & ALARM SYSTEM.

pump fail. The low-pressure limit switch shuts down the pump in the event of pipe failure in the water disposal line from the injection pump.

6. Alarm and Control Panel

The Alarm and Control Panel will be located in the control building and will indicate the status of all operating equipment. A timer will be installed that will bypass the automatic shut-in features for a short time during startup.

7. Emergency Shutdown Valve

The emergency shutdown valve (ESDV-1) is the main control function for shutting in the well automatically. The ESDV-1 is located immediately downstream of the wing valve on the well-head and is a fail-closed valve held open by pneumatic pressure. SDV-2 will also shut down the flow to the separator and will be activated at the same time ESDV-1 is activated.

A normal override will be installed on the water disposal system to allow water injection even if the production testing is shut down.

F. Water Disposal

During the flare test period the separated water would be temporarily stored in the four 400-bbl tanks and analyzed for radioactivity.

The separated water will be disposed of by one of the following methods; however, no order of preference is indicated:

- Vaporized and injected into the flared gas
- Injection into RB-E-01 top chimney
- Injection into the Fawn Creek Government Number 1 Well as done in previous tests

G. Recompletion and Testing of Fort Union Sands

The completion of RB-AR-2 to the Ft. Union sand will be done in such a manner as to allow recompletion of the well back into the middle chimney at some future time. After completion of buildup period on the middle chimney, the well will be recompleted to determine the flow capacity (kh) of one or more zones opposite the top chimney. The procedure is as follows:

1. Remove lubricator and equipment around wellhead.
2. Move in workover unit.

3. Install pump in lines on wing valve and tubing.
4. Kill well with gelled water or mud.
5. Spot cement plug or temporary blocking agent above liner. Use Braden head squeeze.
6. Test to see if plug is holding.
7. Install tubing plug in tubing.
8. Install BOP on tubing head.
9. Pull tubing.
10. Run bridge plug and set at approximately 6,300 feet.
11. Dump bail 2 sacks cement on bridge plug.
12. Pressure test bridge plug to 3,000 psi.
13. Run gamma ray correlation log and perforate deepest selected zone that is to be tested. (Number of perforations and frac size to be designed after evaluation of the logs.)
14. Run tubing and hang above zone.
15. Breakdown perforations and perform small frac job.
16. Clean up well immediately. Release rig.
17. Shut well in and run pressure instrument just below tubing.
18. Establish flow rate and flow test well for two-week period at constant flow rate, if possible.
19. Shut well in for buildup. Estimated time for buildup is a function of the formation kh, but it is anticipated that the buildup will require at least eight weeks and possibly longer.
20. Upon completion of testing and analysis of the data, additional testing may be desirable on a second Ft. Union sand to confirm or define testing results of the first zone.
21. If a second test is to be run, set bridge plug and complete, using steps 13 through 17.

V. RADIOLOGICAL SAFETY AND ENVIRONMENTAL SAMPLING

A. Purpose

This plan provides guidelines for personnel protection from both internal and external radiation to the lowest extent practical. Additionally, it establishes guidelines which will limit contamination to the environment to the lowest levels technically and economically feasible. This plan completely replaces all radiological and environmental sampling plans in the Project Rio Blanco Definition Plan, Volumes I, II, and III, revised January 24, 1973, except as stated in Paragraph V-F.

B. Scope

This procedure sets forth the minimum safety criteria for environmental protection, reentry drilling operations into the second Rio Blanco cavity, sidewall sampling, coring, and subsequent production testing. This will be a phased operation for radiological control purposes. The controls are established as a function of drilling depth. However, in the event that radiation is encountered prior to the stated depth, full radiological coverage will be implemented.

1. Rig Up and Drill from the Surface to the Kick-Off Point (KOP) at 4,700 Feet

All radiation control and monitoring equipment will be set up simultaneously with rig-up operations. All radiation detection and effluent monitoring devices will be placed in operation and calibrated prior to start of drilling. Every effort will be made to ensure that contaminated equipment, if moved from the RB-E-01 site to the RB-AR-2 site, is controlled to the extent that all radioactive contamination is contained internally. Radiological surveillance will be provided as required during the movement of this equipment. Once it has been determined that all equipment is functioning properly, a stand-down period will be in effect until drilling has reached the KOP.

Fencing, gates, and trailer arrangements should be configured at rig up to permit prompt application of radiation exclusion area controls when contamination is encountered. In general, all trailers should be positioned outside of Radiation Controlled Areas.

2. Drilling from KOP to 5,600 Feet Total Vertical Depth (TVD)

The Radiological Safety Contractor, EIC, shall have minimal personnel available to assure that all systems are operational and to evaluate any alarms. Backshift alarms will be covered on an on-call basis.

3. Drilling from 5,600 Feet TVD to the 7-Inch Casing Point
(at approximately 6,050 Feet TVD)

An increased state of readiness will become effective. The radiological safety contractor will establish minimal around-the-clock coverage. All instrumentation will be placed in operation and necessary recalibration will be performed. Spot checks of drilling chips and mud returns will be made as directed by the Radiological Operations Supervisor (ROS).

4. Drilling Beyond the 7-Inch Casing Point (at approximately 6,050 Feet TVD)

Full radiological controls will be implemented. This will include access control, dosimetry, monitoring, sampling, effluent documentation, and contamination control as specified in this plan.

5. Production Testing

During production testing of the second cavity, the gas will be continuously sampled and monitored for radioactivity content. Radiological controls as specified in Section V-F will be implemented.

C. Criteria

The criteria for radiological protection and managing contaminated equipment and soils are specified in Appendix A.

D. Responsibility

The LLL Operations Director is responsible to the AEC Project Director for the radiological safety of the Rio Blanco Alternate Reentry and Production Testing.

Representatives from LLL Hazards Control, and the AEC/NV Radiation Branch, will alternate as ROS and report to the on-site LLL Operations Director. The ROS is responsible for the overall radiological coordination with the AEC, CONOCO, LLL, EIC, and other organizations as necessary regarding implementation of this radiological safety plan.

The ROS will maintain liaison with the Colorado State Health Department (CSHD) as appropriate.

The EIC shall provide radiological safety support services under contract with CONOCO/CER as directed by the ROS with the concurrence of the on-site CONOCO/CER representative.

The supervisor of each participating organization will be responsible for assuring that his personnel and associated visitors comply with the requirements of this plan.

E. Operational Requirements

1. Generalized Tasks

a. Equipment

The EIC/CER government-owned trailers will be appropriately located to provide entry control, radiological laboratory, and sample preparation facilities. The basic counting and radiological protection equipment includes:

- (1) Liquid scintillation and associated sample preparation equipment.
- (2) Multichannel analyzer.
- (3) Gross alpha and beta counter.
- (4) Thermoluminescent dosimeter (TLD) reader.
- (5) Portable instruments are to include alpha, beta, gamma survey instruments, an anemotherm, explosimeters, toxic gas detection equipment, and moisture analysis gear (i.e., molsieve).
- (6) Oxidizers.
- (7) Krypton monitoring chamber.
- (8) Gas conditioning assembly.
- (9) Respiratory equipment and supplies.
- (10) Additional monitoring and decontamination equipment as required.

b. Radiation Controlled Areas

A Radiation Controlled Area will be established at the RB-AR-2 site for reentry drilling operations in accordance with Part VI-B of this plan. The perimeter of the controlled area will be established by the ROS in coordination with CONOCO. In general, the controlled area will include the rig, related drilling equipment, and contaminated materials storage.

c. Personnel Entry/Exit Requirements and Records

In order that radiological control can be maintained during periods when contamination may be encountered, it is essential that all personnel enter and exit the radiation-controlled area via the EIC access trailer when controls are imposed. These requirements will be modified by the ROS as conditions require.

- (1) To serve as a control point for personnel or vehicular entry into and exit from the controlled area, the access station will be manned on a 24-hour basis when controls are placed in effect. The following services will be provided:

- (a) Issuance and collection of TLDs and/or pocket dosimeters for all personnel entering the controlled area.
- (b) Issuance of proper Anti-C clothing (coveralls, gloves, hoods, booties, masks, etc.) as required and assuring that appropriate clothing is worn in the prescribed manner.
- (c) Limited personnel decontamination facilities.
- (d) Logging of personnel entering and exiting the controlled area.
- (e) Issuance and collection of bioassay kits.
- (f) Alarm notifications.

- (2) Entry Requirements

- (a) Appropriate Anti-C gear will be issued and worn as required by the ROS, depending on the nature and level of the radioactive contamination.
- (b) Signs which list the entry requirements are to be posted by EIC in conspicuous locations.

- (3) Exit Requirements

- (a) All personnel will be monitored out through the access control trailer and will turn in their TLD and/or pocket dosimeter.

- (b) All Anti-C gear will be turned in prior to departing the controlled area. No Anti-C gear will be worn outside of the Radiation Controlled Area.
- (c) Personnel contamination will be kept as low as practical. Field decontamination techniques will be used to reduce skin contamination if required.

d. Dosimetry and Bioassay Requirements

(1) Dosimetry

- (a) A TLD will be worn by all personnel working in the Radiation Controlled Area when controls are imposed. When particulate contamination is encountered, pocket dosimeters will be issued to all personnel working on the rig.
- (b) A dosimetry record as specified by AECM 0525 will be maintained by the EIC of all persons entering the Radiation Controlled Area. TLD badges will be exchanged monthly, or as necessary, and read out and recorded by the EIC; the monthly reports on all participants will be forwarded to the ROS. A copy will be furnished to each participant's employer. A composite copy will be provided through CONOCO/CER to Reynolds Electrical and Engineering Company, Inc., Environmental Sciences Department, for incorporation into the NV master dosimetry file. Radiation exposure reporting will be in accordance with the requirements of AECMs 0525 and 0502.
- (c) Pocket dosimeters will be read when turned in and TLDs will be read and reported to the ROS immediately if pocket dosimeters read in excess of 100 mR.

(2) Bioassay

Urine samples will be collected from all project personnel and analyzed for ^3H and other analyses deemed appropriate by the ROS before the start of reentry drilling below the 7-inch casing point, before production testing, and upon an individual's permanent departure from the site. Urine samples collected from personnel who will routinely work in the Radiation Controlled Area will also be analyzed via gamma spectrometry.

(e) Registration of Radioactive Sources

The EIC will register and maintain a record of each radioactive source having activities greater than the exempt quantities and concentrations listed in Schedules A and B of 10 CFR 30.70 and 30.71.

(f) Radioactive Waste Disposal

The following methods of radioactive waste disposal will be employed (see Appendix A, Part 2):

- (1) Produced tritiated water will be injected into a disposal well or vaporized and injected into the flare.
- (2) Tritiated hydrocarbon condensates will be disposed of by injection into the flare and burned.
- (3) Combustible low-level tritiated solid wastes may be incinerated on site if acceptable under appropriate air pollution regulations.

Soil or other media having levels of tritium in excess of cleanup criteria may be dehydrated on site to reduce the contamination to acceptable levels.

Contaminated waste in excess of off-site unrestricted release criteria or contaminated equipment which cannot be decontaminated to release criteria will be appropriately packaged in accordance with DOT regulations and shipped to an approved radioactivity disposal area.

(g) Equipment and Material Decontamination

All materials leaving the RB-E-01 pad and the RB-AR-2 Radiation Controlled Areas will be inspected by the EIC for radioactive contamination prior to being removed from the site. If necessary, contaminated items will be decontaminated to below the levels given in the AEC radiological safety guidelines (Appendix A). The EIC will maintain adequate records of all equipment and material leaving the site, including description, ownership, monitoring techniques, analytical results, and disposition.

If particulate contamination is encountered and the decision is made to decontaminate on site, an appropriate facility will be constructed.

An alternative to developing on-site decontamination capability would be to fabricate containers to ship all items contaminated with particulate radioactivity to the NTS for decontamination. All shipments would be in accordance with DOT regulations and any appropriate security requirements.

The most economical method for handling particulate-contaminated materials will depend upon the nature and extent of the contamination, as well as the security and water disposal requirements. Since these will not be known in advance, it is recommended that planning be such as to allow either option to be exercised.

(h) Radiological Protection Control

If any radioactivity is detected in excess of levels specified in Items 1 and 2 of the operational guides (Appendix A, Part 2) for a 40-hour workweek, drilling or production testing will be shut down in the most expeditious manner consistent with safety and good practice in operating the equipment involved. The EIC Supervisor of the radiological safety program shall promptly initiate a comprehensive radioactivity survey and appropriate cleanup procedures as directed by the ROS. The LLL Operations Director or AEC Project Director, as appropriate, and CONOCO Manager of Operations together shall determine and institute revised procedures to be followed before project work is resumed.

(i) Radiological Protection Documentation

The EIC will provide the ROS and CONOCO daily operational reports giving the results of all radiation measurements and sample analyses. Results unexpectedly above background will be reported immediately. CONOCO will record volumes of gas and liquids flared or reinjected and CONOCO, through EIC, will correlate volumetric and specific activity data to document total releases of activity. Final release figures will be developed in conjunction with data supplied by LLL.

(j) Constraints on Releases of Radioactivity

Actual releases of radioactivity to the flare stack will be compared with conservative upper-limit predictions appearing in WASH-1519, AEC Final Environmental Statement, Rio Blanco Gas Stimulation Project, April 1972. In the unlikely event that the integrated actual releases appear to be exceeding the predicted releases in such proportions of radionuclides as to increase significantly the downwind dose predictions, the production testing schedule will be modified.

(k) Radiological Safety Indoctrination

A radiological safety indoctrination will be given jointly by the ROS and EIC to all workers prior to the start of reentry operations below the KOP and to new workers as they arrive on site.

(l) Contaminated Water Containment

A Contaminated Water Containment (CWC) system will be constructed at rig up to control waste liquids generated on the rig or which might develop from leaks in the mud train or ancillary rig equipment (e.g., mud tanks, DWC, pipe stand, mud pumps, decontamination facility, etc.). Liquids collected via the CWC system will be sampled in place or pumped to clean holding containers for sampling and subsequent disposal.

(m) Radiological and Analytical Procedures Manual

The EIC shall furnish a radiological and analytical procedures manual and assure that it is in accordance with this plan and its appendices. The analytical procedures shall describe in detail all laboratory procedures and techniques to be used, as well as the resulting sensitivities. The manual shall be submitted, through CONOCO/CER, to LLL, Hazard Control, and the AEC/NV in adequate time for review and approval prior to instituting site radiological controls. The manual will be periodically reviewed and updated to be in accordance with subsequent additions or changes to this plan and appendices.

(n) Winterizing of Equipment

If freezing weather conditions are anticipated during reentry drilling or production testing operations, EIC and the LLL Operations Director shall assure that their equipment is adequately winterized.

2. Drill Rig Radiological Safety and Control

a. Survey and Procedures

- (1) Monitoring personnel will be in continuous attendance when controls are imposed.
- (2) A routine radiological survey of the platform work area will be performed hourly or more often as required. At the same time, combustible and toxic gas survey will be made using appropriate equipment. Cellar surveys shall be made prior to entry, if appropriate.

- (3) Pipe breaks will be monitored as scheduled by the ROS when tripping out of the hole and during logging and survey operations. In no case will the monitor suspend a radiation detector probe, or any other object, in the drill pipe.
- (4) The monitor will work as an integral part of the drill crew to maintain radiation and gas leak surveillance. The monitoring activities must conform to the rig work schedule and extreme safety precautions must always be exercised when performing activities.
- (5) Samples of the return material (mud, drill cutting, etc.) will be periodically checked for alpha, beta, and gamma radiation in accordance with the schedule set forth in Appendix B. If the return material is found to be contaminated, then appropriate steps will be taken to control, contain, and store the contaminated material.
- (6) Eating and smoking will not be permitted inside the Radiation Controlled Area. During these times, eating and smoking will be restricted to designated clean areas away from the rig. Water or beverage drinking is permitted on the rig, but after contamination has been encountered only if disposable cups are used and work gloves are removed. Any exceptions to the above restrictions will require prior approval of the ROS. Large signs will be posted in the rig area by EIC informing rig personnel of any eating or drinking restrictions as they become necessary.
- (7) The ROS will be informed at the time radiation levels greater than twice background are first detected. This report should include:
 - (a) Radiation readings (alpha, beta, and gamma).
 - (b) Type of detection instrument.
 - (c) Location where radiation was detected.
 - (d) Drilling depth at the time radiation was detected.
 - (e) Time of detection.
- (8) Any radiation levels significantly greater than background detected in the work area, which cannot be definitely identified as to type, will necessitate the wearing of full-face masks by all involved personnel. A sufficient number of full-face masks will be

kept on the rig at all times for use by personnel as required.

- (9) Cylinders of breathing air with a manifold and hose capable of a four (4)-mask operation will be on hand at the rig. A weekly operational check will be made of this equipment by the EIC.
- (10) The ROS will be informed of all hazardous conditions that arise during the reentry drilling operations. He will also be informed of any radiation being vented to the atmosphere, including all available information as to the quantity and specific nuclides involved.
- (11) Periodic checks will be made of the drilling mud system (pipes, pumps, tanks, etc.) to detect any uncontained leakage. If leakage is detected, this should be reported immediately to the ROS and CONOCO and repaired by the drilling contractor.
- (12) A scheduled swipe program will be set up by the EIC for all work areas and trailers within the Radiation Controlled Area, as well as selected locations outside the Radiation Controlled Area, to ensure that contamination is not being spread.
- (13) The EIC will maintain a daily log of significant radiological events during the reentry drilling. This log should also include references to important drilling milestones (e.g., loss of fluid, spills, and location, time and date of first activity in various systems, time and date of injections, etc.). A carbon copy of this log will be provided to the ROS and CONOCO daily.

(b) Equipment and Instrument Requirements

- (1) A sensitive beta-gamma detector will be provided in the rig floor work area to sense ^{85}Kr or other fission products. Continuous recording will be maintained in the access control trailer. The detector will be set to alarm at twice the normal upper limit of background readings.
- (2) A shielded scintillation detector will be installed on the mud return line and the output continuously recorded in the access control trailer. It will be set to alarm at twice the normal upper limit of background readings.

- (3) EIC personnel will respond to and investigate with portable instruments any alarm and will take appropriate action.
- (4) Area TLD packets will be placed on each corner of the rig platform and inside each trailer within the Radiation Controlled Area. The exchange frequency will be dependent on the current radiological conditions.
- (5) A low-volume air sampler will be located in the vicinity of the access control trailer.
- (6) Sufficient 55-gal drums will be on site to store contaminated mud or drill cuttings which may be contaminated above allowable limits.
- (7) The krypton monitoring chamber will be installed to sample the gas from the DWC unit. This system will be on line and fully operational using available gas prior to the initial use of the DWC. The system will be activated when the DWC unit is used.
- (8) A second shielded scintillation detector will be installed on the gas flare line downstream of the DWC. Its output will be continuously recorded in the access control trailer. It will be set to alarm at twice the normal upper limit of background readings.

(c) Sample Analysis

The sample acquisition and frequency of analysis is based on drilling depth described in the scope (see Chapter VI-A-2). A general discussion of the types of samples and analyses is set forth below. The sample acquisition schedule is described briefly in Appendix B. A copy of the EIC laboratory analysis forms will be provided daily to the ROS.

- (1) Samples of mud will be obtained from the mud return line and analyzed for particulate fission products by gamma spectra at 1 pCi/ml sensitivity referenced to ^{137}Cs and by liquid scintillation for ^3H at 2 pCi/ml sensitivity. [Gamma spectra referred to here and in subsequent paragraphs will be obtained in the field with a NaI(Tl)-multichannel system. If necessary, selected samples can be evaluated by the EIC or LLL at their home laboratory with a Ge (Li-drifted) detector system.]

- (2) Prior to disposal, samples of liquids from the CWC holding container will be assayed for ^3H and via gamma spectrometry.
- (3) Samples of drill cuttings, when generated, will be analyzed prior to disposal by the same method as used for mud samples. The frequency of analysis will be in accordance with a schedule developed by the ROS.
- (4) A rig air sampler consisting of a particulate filter and a charcoal cartridge will be continuously operated. Filters will be changed periodically. The particulate filter will be analyzed for gross beta and alpha and gamma scanned. The cartridge will be gamma scanned. (Air samplers described here and subsequently will use positive displacement pumps, nominally 3 to 4 CFM.)
- (5) The rig floor air will be sampled for ^3H by using molsieve to absorb the air moisture. Samples will be changed daily and will be assayed for ^3H by liquid scintillation counting with a sensitivity of 2 pCi/ml of water.
- (6) A site air sampler will be operated at a location away from the drill rig. Samples will be collected daily and will be assayed in the same manner as those from the rig air sampler.
- (7) Temperature, barometric pressure, and humidity will be recorded to provide necessary data for quantifying site air and rig air samples. The NOAA/Air Resources Laboratory will provide on loan to EIC a hygrothermograph and shelter for this purpose.
- (8) Because of the near background levels in many of the samples, extra emphasis must be placed on analytical procedures and techniques to prevent cross contamination. EIC will continually review and audit all functions of acquiring and preparing samples to ensure that cross contamination does not occur.

3. Sidewall Sampling

a. Equipment

- (1) EIC will assure that all of the LLL-furnished equipment, such as shipping containers, sample bottles, corks, tongs, etc., are available at the drill site before the sidewall sampling begins.

- (2) All equipment used for the extraction of samples, along with backup equipment, will be tested by EIC before the start of the sidewall sampling.

b. Procedures

- (1) Every effort will be made to develop handling techniques and equipment that will prevent any unnecessary personnel exposure and minimize the spread of radioactive contamination.
- (2) Access to the area will be restricted to those personnel involved with the operation.
- (3) It is anticipated that a detailed radiological procedure for sidewall sampling and coring will be jointly developed by the Radiological Operations Supervisors after sampling requirements are known but prior to beginning sampling operations. This procedure will be issued as an appendix to this plan.
- (4) If other than a sidewall sampling program is to be performed (i.e., coring) this could result in a significant increase in the level of effort required for radiological controls. The particular areas of impact would include: area control, decontamination, coring, waste disposal, environmental sampling, and site cleanup.
- (5) A second monitor will be available to assist in the processing of sidewall samples on the rig.
- (6) An LLL-N Radioactive Shipment Tag stating the contact reading of the highest intensity shipping container and the one meter reading of the aggregate shipment will be affixed to the shipment. Department of Transportation Regulations and AECM 0529 governing the shipment of radioactive material will be complied with by the EIC in preparation of the samples for shipment.

4. Production Proving through the DWC

During production proving through the DWC, the radiological procedures and sampling described in the section on Production Testing will be applicable. Additional samples will be taken when required by the ROS in relation to the operation of the DWC. The krypton chamber will be coupled to the DWC to permit sampling of the gas prior to production testing. Analysis of the gas will be performed to document effluent releases. The presence of H₂S in the gas may require modification of the sampling method.

Flow will be continued through the DWC for a period of time adequate to verify the absence of particulate contamination in the flow streams.

5. Rig Demobilization and Removal of Equipment from the Controlled Area

- a. The decontamination of on-site equipment contaminated with tritium will be performed to achieve surface contamination levels no greater than those specified in Appendix A and/or the guides of AEC Manual Chapter 0524.
- b. Any items contaminated with particulate radioactivity will be placed in a holding area for subsequent movement to an authorized site or for movement to the Nevada Test Site for decontamination and return to the owner.
- c. A log will be maintained by EIC of all items of equipment on which swipes are taken and analyzed. The log will reflect the nomenclature of the equipment, appropriate swipe information, and the date that the equipment was released from the site and disposition.
- d. Swipes will be taken on all items removed from the Radiation Controlled Area. Any others suspected of being contaminated with radioactivity will also be swiped.

6. Production Testing from Second Chimney

a. General

During production testing of the second chimney, the gas produced will be continuously sampled and monitored for radioactivity content. This on-line system will be coupled to the gas line downstream from the separator to permit sampling and analysis of the gas to confirm that it is within the constraints on releases of radioactivity prescribed in WASH-1519, AEC Final Environmental Statement, Rio Blanco Gas Stimulation Project, April 1972. The requirements of this section shall apply until plugging of the well is completed prior to commencing production testing from upper intervals. During the buildup period, the requirements will be modified as appropriate to the activities going on.

b. Equipment for Production Test Sampling System

(See Appendix C for schematic of the production test sampling system.)

c. Site Health Physics

The concentration of ^{85}Kr in the flare gas, even assuming minimal atmospheric dilution from the flare stack, is expected to be well below that which would require personnel dosimetry, that is, one-tenth of the radioactivity concentration guides found in AEC Manual 0524, Table I. The most likely radiation problem, if one exists, is tritium in the form of separated liquids or water vapor dispersed in the atmosphere. Under these circumstances, the following precautionary and documentary measures will be taken. The possibility exists that particulate activity may be detected by gas sampling at the gas conditioner assembly filters. If particulate activity is detected, necessary radiological controls will be instituted.

(1) Thermoluminescent Dosimeters (TLD)

TLDs will not be issued to personnel in general. Personnel handling instrument calibration sources will be required to wear TLDs. Some area TLDs will be placed at specific locations about the site; e.g., at the emplacement well, separator, and flare stack.

(2) Bioassays

All operating personnel (normally those handling or controlling the handling of contaminated material) will submit a urine sample to EIC before the onset of operations or upon an individual's arrival on site and permanent departure from the site. EIC will assay the samples for tritium and any other analyses deemed appropriate by the ROS.

(3) Swipes

A random swipe program will be conducted by the EIC to verify that working, living, and eating areas are radiologically clean. These swipes will be taken at the beginning of the operation and weekly thereafter.

(4) Air Moisture

A molsieve sample of air moisture, representative of site air, will be collected daily and analyzed for tritium by liquid scintillation counting.

(5) Access Control

Access to the site will not be controlled, but a log-in, log-out routine will be provided to document

participants and visitors. EIC will provide the log forms and maintain the log records at a convenient point.

(6) Monitoring

One EIC monitor on each shift will maintain general radiological surveillance of the area to ensure that safe working conditions exist. A log will be maintained of radiologically significant events. A copy of the log will be provided to the ROS on a daily basis.

d. Gas and Water Sampling and Data Acquisition

The flare stack gas will be sampled as in previous production tests and conditioned in the EIC gas conditioner for assay of the dry gas for ^3H and ^{85}Kr . It is not expected that any other gaseous radionuclides will be detected. As necessary, the gas and liquids produced from the Fawn Creek Government Number 1 Well will be periodically assayed for ^3H . Other analyses of produced liquids will be made as detailed below.

(1) ^3H in Gas

The oxidizer will be run daily to combust samples of the gas being released through the flare stack. Three 10-minute runs will be made and the three samples analyzed individually in the TriCarb. This schedule presumes that the EIC krypton chamber recorder indicates a stable condition throughout the period. If the condition is unstable, additional runs will be scheduled. The oxidizer-TriCarb system will be calibrated weekly. In the absence of ^{37}Ar , ^3H data will probably be available from runs of the CER Try-Kry system described below. Because of the expected low ratio of ^3H to ^{85}Kr , the probable errors of these data are estimated to be in the range of 15 percent to 20 percent. They will be available as backup to the oxidizer-TriCarb data.

(2) ^3H in Separator Liquids

A sample of produced water will be taken from the separator daily. If liquid hydrocarbons are present, a sample of these will also be taken at the same time. The water and hydrocarbon samples will be processed and counted in the TriCarb.

(3) Holding Tank Water

Each holding tank will be sampled after filling and held until the sample has been assayed for ^3H and

particulate activity. Analysis will be performed as soon as possible. Upon verification that the activity in the water is within prescribed limits, the water will be released for appropriate disposal. Since it is contemplated that analysis will be performed only on the day shift, filling and sampling of tanks will be scheduled so as to have adequate volumes of water approved for release and available for disposal during nighttime hours to avoid a fill-up of storage volume.

(4) ^{85}Kr in Gas

The EIC krypton chamber will be operated for determining the concentration of ^{85}Kr in the flare gas. The CER Try-Kry will be operated at least once daily and available full time as a backup system. Data from selected intervals will be reduced and correlated with those from the EIC krypton chamber. Both systems will be calibrated at the start and at least weekly thereafter, using standard gases of known composition. The gain of the Try-Kry system will vary with the chemical composition of the sample gas. It will be checked prior to use with the system's ^{55}Fe source. A response check of the EIC krypton chamber will be done daily.

(5) Gas Flare Line Detector

A continuously operating shielded scintillation detector shall be installed on the gas flare line downstream of the separator. The output shall be continuously recorded in the laboratory trailer. It shall be set to alarm at twice the normal upper limit of background readings.

e. Fawn Creek Well Gas Analysis

In the event that contaminated liquids are injected into Fawn Creek Government Number 1 Well, a separate LLL-provided oxidizing system will be provided to burn the Fawn Creek Well gas daily to obtain an adequate sample for analysis. Bottled air will be used to reduce interference from environmental background levels. Analysis of the Fawn Creek gas sample will be performed daily. At the time of the gas analyses, any liquids found in the Fawn Creek Well separator will be assayed for tritium in the same manner as those from the production separator. The results of these analyses will be included on the EIC daily analytical summary sheet. Final Fawn Creek release values will be determined using LLL laboratory analysis. In the event contaminated liquids are not injected into Fawn Creek Government Number 1 Well, the LLL oxidizer system will be used as necessary to evaluate the gas with periodic gas and liquid samples to be assayed for tritium.

f. Daily Effluent Report

The data obtained from the gas and water analyses will be correlated with production test and water disposal data obtained by CONOCO to calculate the daily and cumulative total releases of radioactivity to the atmosphere and to the disposal well. In these calculations, the water vapor content of the flared gas will be calculated on the basis of 100 percent saturation at the separator pressure and temperature conditions, with corrections for gas gravity, if necessary.

The effluent report will be prepared daily by CONOCO and EIC and will summarize the releases for the previous 24-hour period ending at 0800. It will be reviewed by the ROS.

g. Gas Sampling

EIC will collect gas samples (500-cc bottle) and time-correlated liquid samples (25ml minimum) of separator water and hydrocarbon condensate (100ml minimum) (if available) for LLL in accordance with the following schedule:

Start-up: One sample after about 1MMCF of dry gas flowed.

Initial

Drawdown: Daily samples or samples at 5MMCF intervals (if high-rate rapid drawdown, daily samples will be adequate).

Extended

Flowing: Weekly samples or samples at 5MMCF intervals (whichever is more frequent).

Shut-in: One final sample just prior to shut-in.

Note: Samples will be spaced to limit to approximately 15 samples for each test period. All liquid samples for off-site tritium analysis will be collected in glass containers.

In addition, silica gel/charcoal filter samples of large volumes of flowing gas will be taken at intervals during the test (e.g., weeks 1, 2, 5, and 8 of an eight-week test; or at the start, middle, and end of a short duration test).

Gas samples will be taken downstream from the separator, without filtration, to avoid perturbation of the chimney gas composition. Sample bottles must be flushed adequately to eliminate air contamination of the sampled gas.

Flushing should be by flow through the bottle and not by repetitive filling and venting. If possible, the gas will be exhausted back into the flare line. Dry gas pressure in a 500-cc bottle must exceed 300 psig to provide an adequate volume of sample for analyses. More than one bottle may be used to obtain sufficient sample if the gas pressure falls below 300 psig.

The use of evacuated tanks as a metering reservoir for the gas passing the silica gel/charcoal filter beds will be acceptable as long as steam condensation in the tanks is not significant.

All samples should be labeled with their date, time, source, pressure, temperature, and such well performance data (pressure, temperature, flow rate, cumulative flow, etc.) as are available and appropriate to the sample time. Shipment of the samples to LLL will be made within three days of their collection. These samples will be shipped collect via motor freight. Any other shipping arrangements will be the responsibility of the recipient. EIC shall assure that these samples are appropriately packaged and shipped in accordance with DOT and AECM 0529 regulations. EIC will also collect samples as requested by outside agencies, but on a noninterference basis.

7. Production Testing from Upper Intervals

During the drawdown period for each zone tested opposite the top chimney, the very remote possibility exists that gaseous radioactivity, ^{85}Kr and ^3H , may be produced. Using the ^{85}Kr as a tracer, the CER Try-Kry will be operated continuously with a sensitivity for detection of about 0.02 pCi $^{85}\text{Kr}/\text{cc}$ of gas.

EIC will provide adequate personnel and equipment to determine the radioactivity content of the returned hydrofracture liquids, and to handle the disposal of these liquids in an appropriate manner as determined by the ROS.

If detectable quantities of radioactivity are present in the gas or separated liquids, an evaluation will be made to determine the appropriate radiological controls for subsequent testing.

Prior to conclusion of the production testing of each zone, a grab sample of gas and liquids will be collected and sent to LLL for detailed analyses.

8. Standby Requirements

When operations are to be temporarily interrupted and the site left unattended except for periodic surveillance, then the radiological criteria for site standby in Appendix A shall be followed. Any equipment or materials remaining on site shall be documented and labeled as to its radiological condition. A status report showing the radiological conditions of the site shall be provided to AEC/NV by EIC through CONOCO. Any subsequent operation not involving CONOCO will require that the operating organization submit a similar report to the AEC/NV for approval.

9. Reporting Requirements

The Technical and Safety Reporting Plan described in Chapter VIII is applicable to the alternate reentry/production-related tasks. In addition to the reports listed in Chapter VIII, the following reports will also be issued:

a. EIC Daily Operation Log (EIC)

Requirements for this report are described in Section V-E.

b. EIC Daily Analytical Summary Sheet (EIC)

This report will be a summary of daily and cumulative effluent release data collated from the on-site measurements. (This will also include any Fawn Creek Well gas and liquid radiological data.) It will include both gaseous release data and liquid disposal data.

c. Standby Status Report(s) (EIC/CONOCO)

This report will include adequate documentation of the site radiological conditions at the time of standby (e.g., known spills and levels involved, flare stack soil levels, waste on hand, and storage location). This report shall be submitted within 30 days after shutdown.

d. Operational Safety, Environmental Protection, and Documentation Report (CONOCO)

This report shall summarize the daily effluent releases, LLL gas sampling data, and environmental monitoring data. The report is to be submitted in draft within six months following completion of the project.

e. Environmental Monitoring Summary Report (CONOCO)

Reports will be submitted to fulfill the requirements of AECM 0513.

f. Contamination Clearance Report (NV/LLL/CONOCO)

This report will be submitted to fulfill the requirements of AECM 5301. (See Appendix A, Part I, Section III, D.)

g. AEC Project Director Completion Report for Reentry and Production Testing (CONOCO/LLL/NV)

To include all available data from the completion of flaring to plus 30 days. Inputs are to be received by NV within 45 days after completion of flaring.

h. EIC Raw Data Analytical Reports

Completed raw data forms from the EIC on-site laboratory will be submitted to NV on a weekly basis.

i. LLL Sample Analysis Reports

Preliminary and final reports of analysis of samples sent to LLL shall be submitted to CONOCO, CER, and NV.

F. Environmental Sampling Program

1. Environmental Sampling Program

The existing environmental sampling program will be continued through the quarter-year ending July 31, 1974, as stated in the Operational Safety and Environmental Monitoring for Extended Flaring Program dated January 24, 1974.

Review and evaluation of the results of the extensive environmental monitoring program conducted for previous operations indicates that this level of effort is no longer warranted.

An Off-Site Environmental Monitoring Program at a reduced level of effort will be conducted during RB-AR-2 reentry drilling and production testing operations. The Environmental Monitoring Program is shown in the table below:

<u>Environmental Sampling Program</u>					
<u>Start</u>	<u>Sample Type</u>	<u>Sampling Medium</u>	<u>Location</u>	<u>Analyses*</u>	<u>Frequency</u>
7" Casing Point (Drilling depth about 6,050 ft. TVD)	Air Sampler	Paper/Charcoal	Norrell Ranch Brennan Ranch MHF Location	Gross Beta Gamma Spectral	Paper--Every 2 days Charcoal--Every 6 days

Start	Sample Type	Sampling Medium	Location	Analyses*	Frequency
Same as above	Air Moisture	Molysieve	Drill Site MHF Site Brennan Cabin (3.5 mi) Norrell Ranch P-L Ranch	³ H-Liquid Scintilla- tion	2 days
Same as above	Precipi- tation	Precipi- tation	Flare Stack 2 mi. Upstream 0.8 mi. Down- stream (MHF) Norrell Ranch	³ H-Liquid Scintilla- tion	Opportunity
Completion of produc- tion test- ing	Soil	Soil Moisture	Samples will be collected from upridge (WNW), down- ridge (ESE), NNE along contour lines, and SW across the gulch at about 100, 200, and 400-foot radii or fur- ther at 400- foot intervals until back- ground is obtained.	³ H-Liquid Scintilla- tion	After pro- duction testing
Start of injection into Fawn Creek Govt. No. 1 Well**	Water Well Samples	Water	RB-D-01 RB-W-01 RB-S-03	³ H-Liquid Scintilla- tion	Weekly/ monthly beginning one month after injection stops for one year.
Drilling depth (TVD) 6,050'	Surface Water	Water	Fawn Creek 1 mile above and 1 mile below RB-AR-2	³ H-Liquid Scintilla- tion and Gamma Spectral Analysis	Weekly

Start	Sample Type	Sampling Medium	Location	Analyses	Frequency
Same as above	Fawn Creek Sediments, Algae/Moss	Sediment and sediment moisture. Algae and/or moss as solids.	Fawn Creek by pad area, 100 feet, 0.5 and 1.0 mile downstream.	³ H-Liquid Scintillation and Gamma Spectral Analysis	Prior to drilling beyond 6,050' (TVD), before production testing, and after production testing.

*All Analysis will be performed in the on-site laboratory facility.

**In the event that Fawn Creek Government Number 1 Well is not used as a disposal well, the present sampling program for these wells will be continued.

An increased level of effort will be instituted if particulate activity is detected, or any other time it is deemed necessary by the ROS.

2. Long-Term Hydrologic Surveillance Program

This program is described in Project Definition Plan, Vol. II, Section VII-B-3.

VI. SITE ROLL-UP

A. Documentation

The radiological condition of the site will be adequately documented to assure compliance with the AEC Headquarters site roll-up criteria. EIC, through CONOCO, shall provide a report to AEC/NV describing the radiological condition of the site (see Section V-I-6). EIC will provide AEC/NV, through CONOCO and the ROS, a proposed detailed sampling program designed to achieve the required site documentation; and to assist in planning final roll-up activities.

B. Equipment Removal

All equipment and material to be removed from the site will be monitored prior to leaving the site to assure that all items meet the radiological criteria for unrestricted off-site use.

At the conclusion of this experiment, all facilities not anticipated for further experimentation will be removed and only those items associated with a standard completed gas well will remain. The piping, tankage, production equipment, flare stack, and all other equipment will be removed from the site at the conclusion of all reentry and testing operations.

C. Decontamination

Attempts will be made to decontaminate contaminated equipment and materials where economically and technically feasible so as to enable unrestricted off-site release. An evaluation will be made as to the cost and feasibility to decontaminate certain items (e.g., separator, large-volume tanks, equipment with no access to internal surfaces, large quantities of small items not economically feasible to swipe, etc.) to assist in determining whether they should be decontaminated or appropriately packaged for shipment to an authorized disposal or storage site.

Any radioactive waste generated during the project and remaining on site will be disposed of in accordance with the previous section on waste disposal and Appendix A.

However, if any future activities involving the possibility of further contamination are contemplated, final cleanup would be postponed. Operations beyond the scope of this PDP will be the responsibility of the organizations involved in any future programs. The decontamination and cleanup of the area and equipment being used will then be the responsibility of those organizations.

VII. PROGRAM MANAGEMENT

A. Planning and Administration

1. Definition

Participants in Project Rio Blanco as used in this Definition Plan shall be defined to include industrial sponsors, financial and technical Participants, and shall consist of the following organizations: AEC, CER, CONOCO, EG&G, Equity, and LLL.

2. Atomic Energy Commission

The AEC, through the Manager, NV, shall provide an AEC Project Director responsible for all project-related activities assigned to the Government by Contract AT(26-1)-589. The AEC Project Director shall further establish and staff the necessary elements to satisfy those responsibilities.

The areas of authority and responsibility of the AEC Project Director (except as delegated to the LLL by the AEC Project Director) are as follows:

- a. Provide one or more contractors to conduct the alternate reentry drilling program as described in Section III of this Definition Plan.
- b. Review and certify the provisions for safety of on- and off-site personnel. Provide and interpret radiological control and documentation criteria.
- c. Management of AEC activities on site.
- d. Security control of any classified material until disposal of or shipped off site.

3. Lawrence Livermore Laboratory

The LLL will provide an Operations Director. This individual, or his designee, will be responsible to the AEC Project Director for tasks delegated by the AEC Project Director. Lawrence Livermore Laboratory shall provide the necessary staff to satisfy LLL's responsibilities.

4. Continental Oil Company

CONOCO will appoint a Project Director. This individual, or his designee, will be responsible for all functions that are not the responsibility of the Government and shall act as

CONOCO's representative in dealings with the Government. He may delegate his authority as required for efficient operation of the project. CONOCO shall provide the necessary staff to satisfy CONOCO's responsibilities.

The areas of authority and responsibility of the CONOCO Project Director are as follows:

- a. Provide technical direction of the drilling program.
- b. Provide for the conduct of production testing activities.
- c. Provide one or more contractors to conduct on- and off-site radiological safety and environmental monitoring services.
- d. Management of all CONOCO and CER activities on site.

5. Senior Review Panel

The Rio Blanco Senior Review Panel, established in November, 1973, will continue to function as the senior management review committee. The Senior Review Panel, consisting of one member each from the AEC, LLL, CONOCO, Equity, and CER will be responsible for the following:

- a. Adopting this revised Project Definition Plan for alternate reentry drilling and production testing.
- b. Approving all major changes to the revised plan.
- c. Determining solutions of significant matters which are unresolved between project Participants.
- d. Monitoring overall project progress, including cost analysis and updating to be kept abreast of possible overruns.

B. Field Operations

1. Atomic Energy Commission

- a. The Project Director will designate an individual who will provide necessary support services to assure compliance of the drilling contractor's work with the approved program (contract specifications) and program schedule.
- b. The AEC Project Director will delegate to the LLL Operations Director responsibility for directing the on-site radiological safety and environmental monitoring operations.

- c. The LLL Operations Director will delegate to an LLL Drilling Engineer the responsibility for conduct of all logging and sidewall sampling, subject to the provisions which follow in Section VII-B-3.

2. Continental Oil Company

- a. CONOCO will designate an Operations Manager who will direct the drilling and production testing operations, subject to the provisions which follow in Section VII-B-3.
- b. The CONOCO Operations Manager has the authority to make decisions on any of the drilling or testing operations that require immediate attention to prevent or minimize a hazardous situation that appears imminent. In situations where immediate action is not required, the decisions should be handled as described in Section VII-B-3.

3. Provisions

- a. The LLL Drilling Engineer and the CONOCO Operations Manager are each authorized to disapprove planned actions or to suspend the operations if, in their judgment, the plans or the operation in progress jeopardizes the safety or technical objectives of the project. In this event, the site is to be placed in a safe standby configuration, and project Participants will assist in the attempt to develop an agreed plan or resolve or remedy the cause of the suspension of operations. Resumption of operations will require agreement of project Participants.
- b. Except as provided in the next paragraph, in the event that the LLL Drilling Engineer and CONOCO Operations Manager are after consultation with project Participants unable to reach agreement on the course of action to be implemented, the Senior Review Panel will be contacted and briefed on the alternatives. The decision of the Panel with respect to subsequent action will be implemented by the field representatives.
- c. In the event that the LLL Drilling Engineer and CONOCO Operations Manager agree on suspension of operations at a point which eliminates the possibility of achieving a major technical objective of the program, the Senior Review Panel will be contacted for concurrence prior to initiating any action which precludes proceeding to that objective.

VIII. TECHNICAL DOCUMENTATION AND REPORTING

A. General

The AEC requires publication of unclassified scientific and technical information relating to the use of nuclear explosives for peaceful applications. The Peaceful Nuclear Explosives (PNE) report series has been instituted to provide unclassified literature on each Plowshare project. Participants will report on their unclassified project results, either as articles in technical journals or in special reports. These reports inform scientists and the general public of Plowshare project results and aid in developing understanding and acceptance of the use of nuclear explosives for peaceful applications. Publication in one form does not preclude publishing results in other forms if the authors so desire. Also, these requirements in no way conflict with the responsibilities of the AEC Project Director to issue such operational reports or special reports as are required by other authorities.

B. Basic Principles

1. Technical Evaluation

Participants may jointly or severally study and evaluate all data relating to the geologic formations, hydrocarbons, reservoir characteristics, producing methods, and effects of the experiment upon the reservoir and the production of gas.

2. Exchange of Information

Each Participant shall use its best efforts to keep the other parties fully and currently informed of technical data, scientific analyses, and the interpretations generated by each in the performance of Project Rio Blanco.

3. Release of Information

All publication or dissemination of technical data resulting from, or in the course of, Project Rio Blanco will be in accordance with this Technical Information and Reporting Plan.

When the public issuance of any new information* concerning the project is necessary or desirable in the opinion of any party, wherever possible, draft, or final materials will be submitted

*For the purpose of this Plan, "new information" or "new data" includes technical or safety information pertaining to the project that has not been publicly released, as well as "new interpretations" of project data that have been publicly released.

to the other project Participants in advance of release. Except as otherwise required by applicable laws, regulations, or governmental procedures, public releases will not be made until after such coordination and required prepublication patent review. The foregoing is intended to establish a pattern of cooperation and is not intended to permit any party to prevent a public release of any other party except upon a showing of good cause.

4. Atomic Energy Material

Reports relating to atomic energy may be used by the Commission for any purpose in fulfillment of the obligations and requirements of the Atomic Energy Act, including dissemination and publication.

5. Technical Papers

When project Participants present papers on Project Rio Blanco at technical symposia, the papers will be published in the proceedings of those symposia or as formal reports at the earliest practicable time after the symposium. Papers should be coordinated with Participants and, if possible, receive the necessary reviews prior to being presented.

C. Proprietary Information

The CONOCO Project Director, when delivering any information to the NV Contracting Officer, shall, if the information includes any secret processes, technical information, or know-how which is deemed to be "proprietary" to CONOCO or its contractors, note the same on the cover of the document and identify the specific proprietary information. The NV Contracting Officer shall handle and control the information identified as proprietary in accordance with NV Chapter 2104.

D. Review and Processing of Formal Reports, Symposia Presentations, and Informational Release to the Public

1. Patent Review

Manuscripts for all formal reports and any other material containing "new data" intended for public release (e.g., papers for presentation at professional meetings or journal publications, data (other than raw data) for the open file, etc.) are required to have a patent review. Manuscripts will be submitted for patent review through customary channels to NV and CONOCO prior to being released for public dissemination. This requirement also applies to new interpretations of data that have previously been publicly released.

When submitting a manuscript for prepublication patent review, CONOCO shall advise whether or not any inventions or discoveries are disclosed therein. If the disclosed inventions or discoveries have been previously reported, CONOCO shall identify them by AEC invention disclosure number. CONOCO shall also set forth its (or its contractors) position with respect to publication, reporting, and patent action on any disclosed inventions or discoveries not previously reported.

The reviewing office will either: (1) advise that there are no objections from the patent standpoint to the release of the manuscript, or (2) provide other instructions as appropriate.

2. Reciprocal Exchange

To keep each party fully informed, and to provide for consistency, accuracy, and comment, project Participants should forward drafts of manuscripts to other project Participants in advance of release. Those parties receiving material shall not release the material until it has been released by the originator. This exchange does not in any sense provide for a technical review of the work of one participant by others.

3. Submission of Material for Publication

Following completion of the previous steps, material may be publicly released.

4. Open File

Preliminary interpretive data, project reports, journal articles, etc., will be provided to the Open File after they are reviewed, coordinated with the Participants, and released for publication.

All materials furnished the Rio Blanco Open File are to be submitted in 17 copies to the NV Reports Coordinator for disposition and five copies to CONOCO.

5. Reports to be Issued

The following are the types of reports which are expected to be published during the course of the Project Rio Blanco Alternate Reentry-2:

- a. Radiological, On- and Off-Site (CONOCO/EIC)
- b. Gas Sampling (LLL)
- c. Data Report--(NV) (At specified intervals NV will issue data reports which will include raw data, gas flow measurements, pressure, and temperature readings, etc.)

- d. Project Rio Blanco Reservoir Test and Evaluation (LLL)
 - e. Project Rio Blanco Reentry Drilling (NV/CONOCO)
 - f. Project Rio Blanco Operational Safety and Environmental Protection and Documentation Report (CONOCO)
 - g. Project Rio Blanco Summary of Reentry Related Activities (NV)
6. Preparation of Reports for Publication
- a. Report Identification

Identification numbers will be assigned by NV Reports Coordinator to all formal reports issued on Project Rio Blanco.
 - b. Printing and Distribution of Reports
 - (1) Distribution of Project Rio Blanco reports and technical papers to project Participants should be as follows:

<u>Participants</u>	<u>Number of Copies</u>
CONOCO	5
DAT	2
LLL	20
NV (Open File)	17
NV	50
CER	3
Equity	3
EG&G	3

(2) Journal Articles

If technical papers or articles pertaining to Project Rio Blanco data are submitted for publication in professional or trade journals, copies of preprints or reprints should be furnished to project Participants when they become available. The NV Reports Coordinator will provide one copy to AEC TIC for abstracting and indexing in Nuclear Science Abstracts.

c. Suggested Outline for Organization of Formal Reports

Following is the suggested organization for formal Rio Blanco reports:

(1) Title Page

Include the following:

- "PROJECT RIO BLANCO"
- Report number--"PNE-RB-__"
- Report title
- Name of author(s) and organization
- Date manuscript is submitted
- The following legend:

"Contract AT-(26-1)-589 between the United States of America, acting through the Atomic Energy Commission, and Continental Oil Company."

(2) Abstract

(3) Preface (optional)

(4) Acknowledgment (optional)

(5) Table of Contents

(6) Introduction

- Objective
- Conclusions
- Recommendations
- Background
- Theory

(7) Procedures

- Experimental or Operational Plan
- Instrumentation and/or Techniques

- (8) Results
- (9) Discussion and Interpretation (optional)
- (10) References (optional)
- (11) Appendices (optional)

IX. SECURITY PROCEDURES

A. General

This general procedure sets forth the minimum security controls for reentry drilling operations at RB-AR-2; i.e., sidewall sampling, coring, and subsequent production testing.

The controls to be effected are the responsibility of the AEC Project Director. They are as follows:

1. At any time classified contaminated particulate matter, sidewall samples, cavity debris, drilling chips, mud returns, equipment, or any other classified contaminated material is brought to the surface at the RB Reentry Area RB-AR-2 drill site, it will be under the continuous custody of a "Q" access authorized person until such time as it is disposed of, returned downhole, decontaminated, or shipped off site.
2. Shipment off site must be under controls approved by the NV Security Division and the ROS. Classified contaminated material must also be packaged or contained in such a manner as to meet DOT standards. Classified material may be removed from RB-AR-2 under the following conditions:
 - a. An operational necessity exists.
 - b. Material is appropriately packaged in accordance with DOT regulations.
 - c. An appropriate classified shipping address label is attached.
 - d. The personnel removing the material have "Q" access authorizations and have been authorized in writing by a member of the NV Principal Staff (if an AEC employee) or by contractor management who have been authorized in writing to grant such authority.
 - e. The NV Security Division must be notified and must approve all movement of classified material from RB-AR-2.
 - f. A dated and signed receipt, identifying the material involved, will be maintained at the RB-AR-2 site.
 - g. The material removed must be in the continuous personal custody of the person transporting same except that temporary storage may be approved at AEC or AEC contractor-approved storage facilities.

B. Classified Material

Classified material brought to the surface at RB-AR-2 should be (size permitting) maintained in a locked storage container (transportainer, trailer, repository, etc.) on site until disposed of. Keys to the locks or access to combinations to such containers must be limited to "Q" access authorized personnel.

Should it be determined that classified material brought to the surface at RB-AR-2 is needed at LLL, Livermore, California, and the material is small enough to ship by air, the following procedure may be utilized:

1. A "Q" access authorized person could depart RB-AR-2 with the material appropriately packaged, labeled, and addressed during the morning hours on a weekday. Morning departure is required in order to have the classified material at an REA Air Express office in Denver, Colorado, or Salt Lake City, Utah, prior to COB. Such material would be placed in REA hands for air express Armed Surveillance Protective Service movement to its destination. This service is not available closer to RB-AR-2 than the two mentioned locations.
2. An alternate method of transfer for material too large for air express is to use courier service to destination. Large material could also be moved to the AEC Grand Junction Operations Office (with prior advance arrangements) for storage under security controls pending further shipment to a destination.

Other means of shipment, including the use of AEC aircraft from Colorado cities, could be utilized if operationally feasible.

Upon the first contaminated classified material being brought to the surface, the AEC or LLL Senior Site Representative present will notify the NV Security Division and advise of this fact and controls to be exercised to assure that such material is provided adequate protection.

X. PUBLIC AFFAIRS

A. General

For general policy guidance, the following will apply to the Project Rio Blanco Alternate Reentry Well and subsequent production testing: Project Rio Blanco Definition Plan, Revised January 24, 1973, Vol. I, Chapter VII-B, Public Affairs Activities; Vol. II, Chapter X, Public Affairs and Information Task; and Vol. III, Chapter VIII, Public Affairs. Organizational interfaces in these references will apply.

Specific public information actions to support the Program are:

1. News Announcements

News announcements should be issued at the times indicated:

- a. The fact that a new well will be drilled with more production testing at least three days prior to moving rig on site.
 - b. Availability of environmental assessment statement and summary thereof when such statement is prepared.
 - c. Start of drilling when rig is in place.
 - d. Penetration of the lower chimney when that is an established fact.
 - e. Plugging of well and start of production tests in the unfractured zone.
 - f. Production testing from the nuclear zone and unfractured zone when the scheduled date for either becomes known.
 - g. Completion of production testing when that occurs.
2. All accidents and incidents of consequence will be reported publicly as soon as possible.
 3. Any incident involving the unplanned release of any radioactive material, or deviation from planned procedures involving radioactive material, will be reported to OIS/NV immediately.

B. Briefings and Meetings

1. State officials will be briefed prior to the first announcement.

2. A site visit and briefing will be conducted there for interested officials, newsmen, and others when production testing begins.
3. Individual newsmen and officials should be escorted to the site on request and briefed by on-site personnel whenever possible.

XI. SCHEDULING

The schedule of major items, with respect to the period of time expected, is shown in Figure X-1.

SCHEDULE OF MAJOR ACTIVITIES

FIG. X-1

XII. COST ESTIMATES

The following cost estimates are examples of the costs which will be assumed and paid by the AEC and CONOCO in accordance with Contract AT(26-1)-589.

A. DRILLING

	<u>Total</u>
1. Materials and Services (Government furnished)	
a. Site preparation (including cellar and conductor pipe)	\$ 5,000
b. 200 feet of 16-inch and 20 feet of 24-inch casing	3,000
c. 2,300 feet of 10 3/4-inch casing	18,170
d. 6,900 feet of 7-inch casing	50,000
e. 500 feet of 5-inch liner	2,500
f. 6,900 feet of 2 7/8-inch tubing	11,000
g. Wellhead assembly	25,000
h. Special collars and drill pipe	3,500
i. Sidewall sampling service	6,000
j. Drip pans	25,000
k. Communications and power service	3,000
l. Miscellaneous (janitor, water, gas, etc.)	5,000
m. G&A @ 11 percent	<u>17,288</u>
Total Materials and Services	\$174,458
2. Drilling Contractor	
a. Mobilization & Demobilization (including pony base)	\$ 89,250
b. Drilling w & w/o CP 83 days @ \$2,784	231,072
c. Standby ready two days @ \$2,592	<u>5,184</u>
Total Drilling Contractor	\$325,506

3. Drilling Contractor Furnished Items, Government Reimbursable

	<u>Total</u>
a. Cementing	\$ 28,000
b. Otis	25,000
c. DWC	15,000
d. Casing crews	5,000
e. Welders	3,000
f. Drilling mud	40,000
g. Drill bits	25,000
h. Dyna Drill & directional drilling	50,000
i. Logging	20,000
j. Perforating	3,500
k. 3 1/2-inch drill pipe	4,000
l. Miscellaneous	<u>31,500</u>
Total Drilling Contractor Furnished Items	\$250,000

4. Radiation Safety

a. Personnel (EIC and CER)	\$109,000
b. Supplies	10,300
c. Miscellaneous	<u>20,700</u>
Total Radiation Safety	\$140,000
GRAND TOTAL DRILLING	<u>\$889,964</u>

B. PRODUCTION TESTING---PHASE I

1. Chimney Testing

a. Equipment	\$ 12,500
b. Contract labor	28,000
c. Logistics (including EIC vehicles)	17,000

	<u>Total</u>
d. Road and site work	\$ 5,000
e. Water disposal	5,500
f. Radiation Safety (EIC and CER)	56,000
g. Buildup (labor and logistics)	8,000
h. Miscellaneous	<u>17,000</u>
Total Production Testing--Phase I	<u>\$149,000</u>
C. PRODUCTION TESTING--PHASE II	
1. Recomplete and test first Ft. Union zone (including minimum of eight weeks' buildup)	
a. Rig	\$ 15,000
b. Services (logging, perforating, fracturing)	20,000
c. Contract labor	6,000
d. Test equipment	5,000
e. Test engineer (including vehicle)	6,000
f. Miscellaneous	6,000
g. Radiation Safety (EIC and CER)	<u>6,000</u>
Subtotal	\$ 64,000
2. Recomplete and test second zone (including eight weeks' buildup)	
a. Rig	\$ 6,000
b. Services (logging, perforating, fracturing)	19,000
c. Labor	6,000
d. Test engineer (including vehicle)	5,500
e. Miscellaneous	3,500
f. Radiation Safety (EIC and CER)	<u>6,000</u>
Subtotal	\$ 46,000
Total Production Testing--Phase II	<u>\$110,000</u>

	<u>Total</u>
D. SITE CLEANUP	
1. Radiation Safety (EIC and CER)	\$ 15,000
2. Labor	<u>5,000</u>
Total Site Cleanup	<u>\$ 20,000</u>
E. ENVIRONMENTAL SAMPLING	
Radiation Safety and Final Reports (EIC and CER)	<u>\$ 14,000</u>
Total Environmental Sampling	<u>\$ 14,000</u>
Total (Drilling, Testing, Cleanup, and Environmental Samples)	\$1,182,964
Contingency	17,036
GRAND TOTAL	<u>\$1,200,000</u>

APPENDIX A

PART 1

RADIOLOGICAL SAFETY GUIDES* PROJECT RIO BLANCO

The following guidelines apply to Project Rio Blanco. It is recommended that design and operational activities be conducted within these guidelines in such a manner as to reduce the release of radioactive effluents and radiation exposures to personnel, on and off site, to the lowest practicable levels. Further, with respect to planned operations and any associated controlled releases, exposures to members of the public should not exceed 10 percent of the limits specified in AEC Appendix 0524. For situations involving inadvertent or accidental releases, the overall design of the experimental program should be carefully reviewed to ensure that during the lifetime of the project, there will be no significant uncontrolled release of radioactivity off the controlled area.

I. GENERAL RADIOLOGICAL CRITERIA

The following radiological safety criteria shall apply during the entire operation period of these projects:

- A. For individuals within the controlled area, the radiation protection standards set forth in AEC Appendix 0524, paragraphs I-A and IV shall apply.
- B. For individuals and population groups in uncontrolled areas, 10 percent of the radiation protection standards set forth in AEC Appendix 0524, paragraph II-A shall apply. It is noted that the potential for radiation exposure to individuals in the uncontrolled area from planned operations exists only during the time of production testing (flaring) activities.
- C. In the unlikely event that an inadvertent release of radioactivity to the uncontrolled area occurs, every effort shall be made to reduce potential radiation exposure to individuals off site to the lowest practicable level. Exposure control guidelines shall be consonant with the principles and levels of protective action guidance provided in Federal Radiation Council Reports 5 and 7.

*These guides were extracted from letter, Kelly to Miller, April 17, 1972, "Radiological Safety Guidance for Experiments Involving Nuclear Stimulation of Natural Gas Wells," and letter, Biles to Johnson, April 5, 1973, same title.

- D. All personal property, i.e., buildings, equipment, and materials, to be removed from the site for uncontrolled use shall meet the criteria specified in Table 1. All personal property, transferred from this site to another location where radiological controls are in effect, shall have the external surfaces of such property meet the criteria specified in Table 1, and be packaged for transport in compliance with AECM 0529.

II. STANDBY CONDITION

The following additional radiological safety criteria shall apply when the operations are to be temporarily interrupted and the site placed in a standby condition; i.e., the site is to be left unattended except for periodic surveillance, data collection, and equipment maintenance activities. Methods of disposal of any contaminated personal property, soil, or liquids, to meet this standby criteria, shall be approved by AEC Headquarters. The site shall be fenced to preclude inadvertent access to any remaining equipment, materials, and contaminated land areas. Radiation warning signs are not required if the following criteria are met:

- A. Beta-gamma radiation levels in soil shall not exceed 1 mr/hr above background (including worldwide fallout), at 1 centimeter above the surface as measured with a probe having not more than 7mg per cm² of absorbing material.
- B. Tritium concentrations in soil shall not exceed 3×10^{-2} $\mu\text{Ci/ml}$ of soil moisture above background (including worldwide fallout).
- C. Although no alpha contamination is expected during operations, should such contamination occur, all personal property remaining at the site shall be decontaminated as near as practicable to the criteria specified in Table 1. For soil, the top layer shall not exceed 10,000 dpm/100 cm² gross alpha above background (including worldwide fallout).
- D. Contaminated liquids remaining at the site shall not exceed the standards provided in AEC Appendix 0524, paragraph II.

III. SITE DISPOSAL

Decontamination and cleanup, prior to release of control and responsibility for the site by the AEC, shall be effected after consideration of the following factors: (1) external radiation levels; (2) migration of radionuclides to man through resuspension in air, movement in water, or passage through food chains; (3) unrestricted property use, immediate and potential; (4) decay and other removal processes tending to reduce potential exposure to man and (5) the feasibility, cost, and relative effectiveness of further decontamination activities. The cleanup shall be continued until potential future exposures to man are not likely to exceed a few percent of the limits specified in AEC Appendix 0524, paragraph II-A.

Numerical guidance provided herein should not be exceeded without careful consideration of the reasons for doing so. Different values than those provided here may be approved by AEC Headquarters, on a case-by-case basis.

For purposes of planning for disposal of a site for uncontrolled use, the following radiological safety guidance is provided:

A. Surface Waters

Contaminated surface waters in excess of 0.1 times the concentration values listed in AEC Appendix 0524, Annex A, Table 2, Column 2, shall be disposed of by methods approved by AEC Headquarters.

B. Buildings, Equipment, and Materials

Residual radioactive contamination remaining after cleanup operations shall not exceed the levels specified in Table 1.

C. Soil

Residual contaminated soil to a depth of about four feet shall be decontaminated or treated to the extent practicable and any radioactive waste pits exceeding four feet in depth shall be decontaminated to the full depth of the waste in accord with the following criteria:

1. Soil containing residual tritium concentrations exceeding 3×10^{-2} $\mu\text{Ci/ml}$ of soil moisture shall be excavated for disposition by means approved by AEC Headquarters.
2. Soil containing residual $\beta\gamma$ radiation levels exceeding 0.2 mrad/hr above background (including worldwide fallout) measured at 1 cm shall be excavated for disposition by means approved by AEC Headquarters. After surface restoration, the final average radiation levels shall not exceed 0.05 mrad/hr $\beta\gamma$ above background (including worldwide fallout) measured at 1 cm. All measurements shall be done with a probe having not more than 7mg per cm^2 of absorbing material.
3. Soil gradients shall be examined by suitable sampling and residual contamination shall be removed and disposed of by methods approved by AEC Headquarters when these levels exceed 10^{-5} $\mu\text{Ci/g}$ for $\beta\gamma$ decay modes (except tritium) above background (including worldwide fallout). It is not anticipated that radioactivity with an α decay mode will be encountered. If such should be the case, criteria will be provided by AEC Headquarters.

- D. A final site survey shall be performed prior to release of the site and copies of a report of the cleanup effort and survey results shall be transmitted to AEC Headquarters/AGMES, AT, BM, WMT, and OS. The report on the site cleanup operation shall include a description of the physical and legal measures taken to prevent deep drilling, mining, or other restrictions on use of the site. Agreements or arrangements for subsequent monitoring should also be described. The certification requirement, associated with this report, is defined in AECM-IAD-5301-8, dated February 3, 1972, for all real property and related personal property prior to any disposal or excessing action.
- E. Effective site cleanup should eliminate the need for periodic terrestrial and bioenvironmental surveys and only annual surface and groundwater samples should be required for a period of about five years or until there is reasonable assurance that no transport problems exist. Reports of the annual surveys shall be sent to AEC Headquarters/AGMES, AT, BM, WMT, and OS.

TABLE 1

Isotope ^{2/}	Surface Contamination Levels ^{1/}	
	Removable ^{3/}	Total ^{4/} 5/
U nat, U-235, U-238, Th nat, Th-232, and associated decay products	1,000 dpm or 450 pCi alpha on any 100 cm ²	10,000 dpm or 4,500 pCi alpha on any 100 cm ²
Other isotopes which decay by alpha emission or by spontaneous fission	100 dpm or 45 pCi alpha on any 100 cm ²	1,000 dpm or 450 pCi alpha on any 100 cm ²
Beta-gamma emitters (isotopes with decay modes other than alpha emission or spontaneous fission)	1,000 dpm or 450 pCi beta-gamma on any 100 cm ²	0.4 mrad/hr ^{6/} at 1 cm from the surface

^{1/}As used in this table, dpm (disintegrations per minute) or pCi (picocurie) means the rate of decay by radioactive material as determined by correcting the counts per minute observed by an appropriate detector and count rate meter, for background, efficiency, and geometric factors associated with the instrumentation and survey procedures.

^{2/}Where surface contamination by both alpha and beta-gamma emitting isotopes exists, the limits established for alpha and beta-gamma emitting isotopes shall apply independently.

^{3/}The amount of removable radioactive material on any 100 cm² of surface area may be determined by wiping that area with dry filter or soft absorbent paper and with the application of moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known background, efficiency, and geometry. In determining removable contamination on objects of surface area less than 100 cm², the pertinent levels shall be reduced proportionately, and the entire surface shall be wiped. Alternately, it may be assumed that all of the radioactive material remaining on a surface may be removable, and that amount of radioactive material may be determined by direct measurement with survey instrumentation of sufficient sensitivity to detect levels equivalent to these limits.

^{4/}Alternatively, for total contamination, one may elect to use an average level one half of that listed in this column, provided that:

- a. The average shall be taken over the total area or 10 square meters, whichever is the lesser; and
- b. At no location shall the maximum exceed 2.5 times the level listed in this column.

- 5/ It is assumed that measurements of total contamination are made with instruments having a sensitive cross-sectional area of 100 cm². Measurements made with instruments having more or less than 100 cm² of sensitive area may be related to levels proportionately adjusted, or additional measurements may be made on contiguous areas totaling 100 cm² and the findings added for comparison with the specified levels.
- 6/ Measured through not more than a total of 7 milligrams per square centimeter of absorbing material.

APPENDIX A

PART 2

OPERATIONAL GUIDES

1. Radiation exposure criteria for all project personnel will be in accordance with AEC MC 0524. Radiation exposure criteria for off-site residents will be in accordance with criteria provided by AEC Headquarters.
2. Radioactivity Concentration Guides (RCG) for radioactivity in air and water are also contained in AEC MC 0524. In the event of an inadvertent release of radioactivity and accidental or emergency exposure, AEC MC 0502 and 0524 will be followed.
3. Effluent reporting is to be in accordance with AEC MC 0513. All radioactive shipments will comply with AEC MC 0529 and DOT requirements.
4. In the event of contamination by radioactivity, decontamination shall be in accordance with criteria provided in Part 1 of this Appendix.
5. Prior to disposal, drill cuttings and other solid waste will be analyzed for ^3H and, via gamma spectrometry. If there is no detectable particulate activity and the tritium concentration is equal to or less than 10 pCi/ml, the waste can be disposed of in a routine manner. Waste with tritium concentrations greater than 10 pCi/ml will be controlled and contained on site during project operations.

The method for ultimate disposal will be determined based on the radiological condition of the waste on hand and in consideration of the economical and technical feasibilities of available waste disposal methods. However, waste containing detectable quantities of particulate activity or otherwise exceeding the criteria in Part 1 of Appendix A will be disposed of in accordance with guidance provided by AEC-HQ.

6. If particulate radioactivity is detected in any gas being released, the operation will be shut down. No further gas will be released without the concurrence of the Senior Review Panel.
7. Appropriate AEC Manual Chapters shall apply to the reentry drilling and production testing operations.

APPENDIX B

SAMPLING PROGRAM DRILLBACK

TYPE OF SAMPLE AND ANALYSIS		ALPHA (LAB)	BETA (LAB)	GAMMA SPECTRA (LAB)	GAMMA - SPA (Fixed Scint. Ctr.)	LIQUID SCINTILLATION (TriCarb)
RIG ATMOSPHERE	a. Filter	a. (2) Gross	a. (2) Gross	a. (2) Scan	a. ---	a. ---
	b. Charcoal Cartridge	b. ---	b. ---	b. (2) Scan	b. ---	b. ---
RIG ATMOSPHERIC MOISTURE		---	---	---	---	(2)
SITE AIR	a. Filter	a. (1) Gross	a. (1) Gross	a. (1) Scan	a. ---	a. ---
	b. Charcoal Cartridge	---	---	b. (1) Scan	b. ---	b. ---
GAS FLARE LINE		---	---	---	Cont. Monitor & Record	---
MUD STREAM	a. Fission Product	a. ---	a. ---	a. (2) Scan	a. Cont. Monitor & Record	a. (2)
	b. Drill Cuttings	b. ---	b. ---	b. (3) Scan	b. ---	b. (3)
LIQUID WASTE	Rig Water & Mud	---	---	(3)	---	(3)
AREA SWIPES	Rig Trlrs. Equip.	---	as scheduled	---	---	(1)

- (1) Sample will be taken daily and analyzed.
 (2) Sample will be taken once on each 8-hour shift.
 (3) Sample will be taken when generated and prior to disposal.

APPENDIX-C

PRODUCTION TEST GAS SAMPLING SYSTEM