PNE-RB-18
REV. 1

PROJECT RIO BLANCO
DEFINITION PLAN

VOLUME III
REENTRY-RELATED
DETAILED TASKS

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I. INTRODUCTION

Project Rio Blanco is the first phase of a three-phase program to demonstrate the potential of commercial development of a natural-gas field by nuclear stimulation techniques in the Piceance Basin in Rio Blanco County, Colorado. Because the gas is tightly held within the surrounding rock, this field cannot be developed by conventional stimulation methods.

The first phase will consist of simultaneously detonating three nuclear explosives at different depths within the Fort Union and Mesaverde formations. The detonation is designed to stimulate a 1,350-foot vertical section of the Fort Union and Mesaverde formations. After a 3-month waiting period, a reentry well will be drilled into the gas-filled chimney, and the reservoir testing and evaluation will start.

Because of the extensive detail required in planning Project Rio Blanco, the Definition Plan is presented in three volumes.

Volume I is a general description of the entire project.

Volume II contains the tasks needed for the operational scope of work related to the detonation such as site construction, power installation and distribution, drilling of the emplacement well, stemming plans, seismic effects documentation, and ground water protection program.

Volume III incorporates all of the activities related to the chimney reentry and reservoir testing and evaluation. Some tasks will begin prior to detonation and continue through the reentry. Other tasks, such as general site activities, will of necessity be built upon preceding activities detailed in Volume II. Summary schedules and support items are included in all three volumes.

In addition to the three volumes, detailed supplementary reports have been prepared. These reports are:

Rio Blanco Demonstration Program
Project Rio Blanco Environmental Impact Evaluation
Project Rio Blanco Geology of the Piceance Basin
Project Rio Blanco Hydrology of the Piceance Basin
Project Rio Blanco Reservoir Report
Project Rio Blanco LLL Technical Studies
Project Rio Blanco Operations Plan [Lawrence Livermore Laboratory (LLL) Dec. 1971]

Figures I-1 and I-2 show the major project locations.

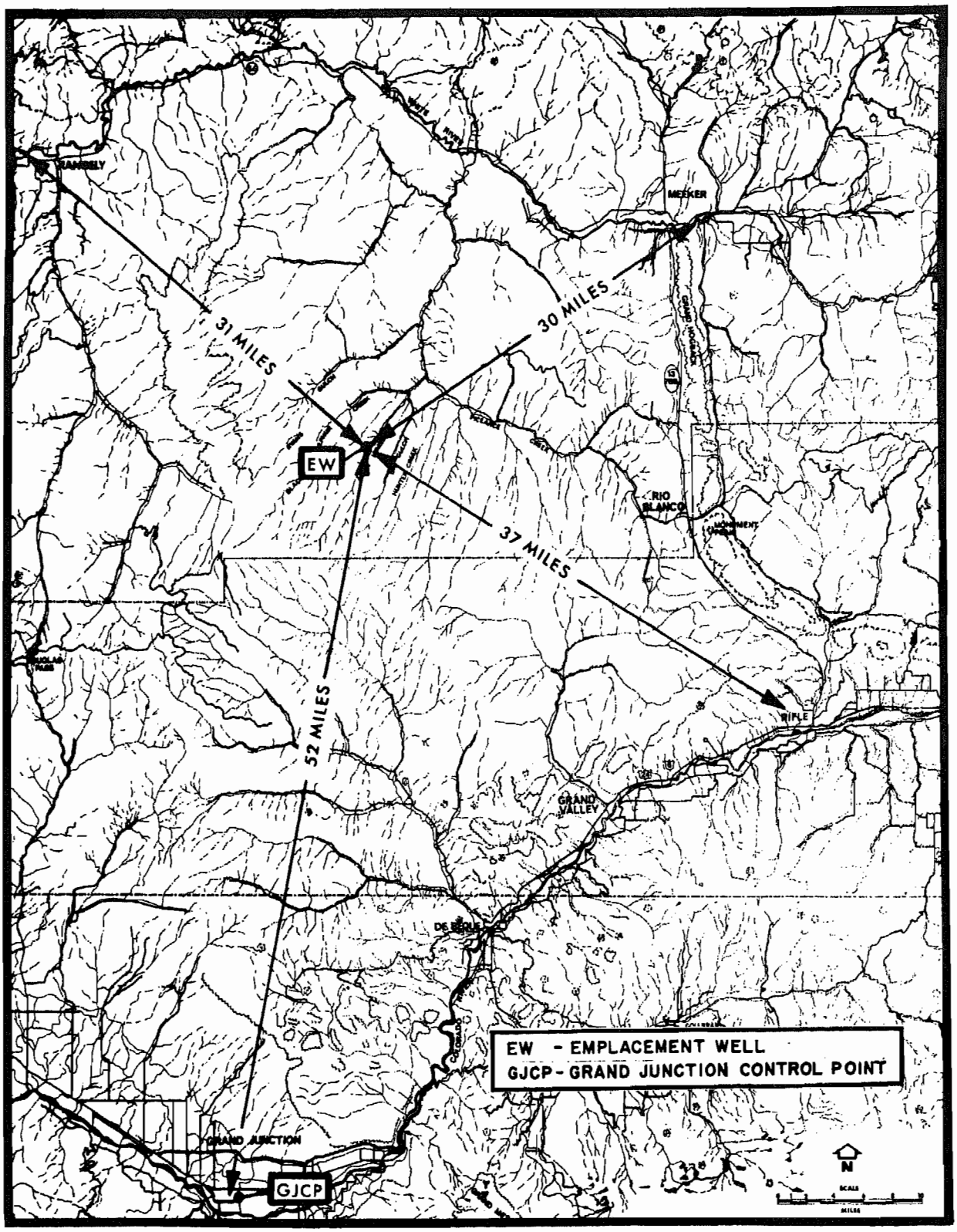

Figure I-1. Project Rio Blanco site map.

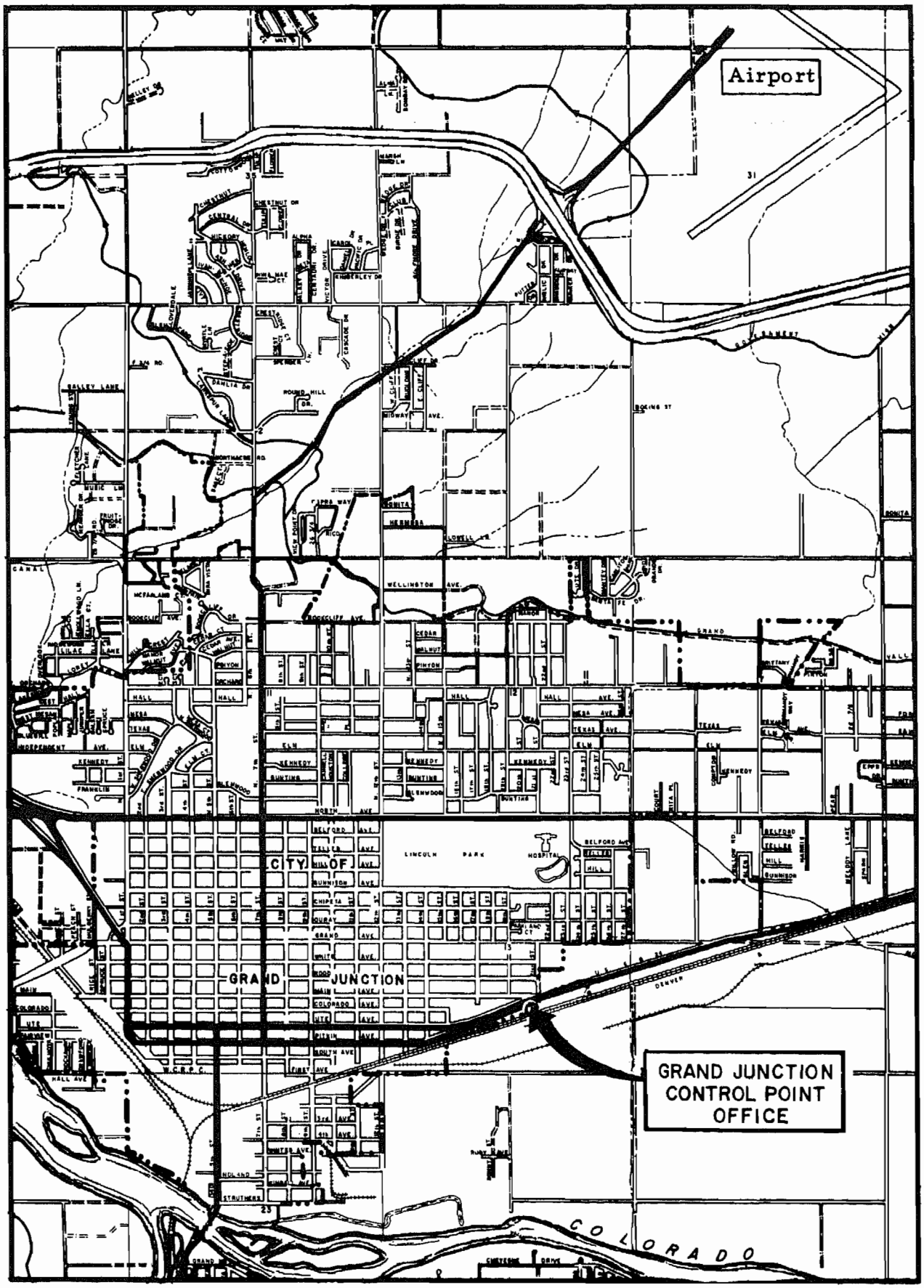

Figure I-2. Location of Grand Junction Control Point Office.

II. GENERALIZED SITE ACTIVITIES

A. SITE PREPARATION

At the start of postdetonation activities, the Fawn Creek access road and Emplacement Well (EW) area will be regraded and prepared for the reentry drilling and production testing.

Trailers will be provided for the LLL/Atomic Energy Commission (AEC), CER Geonuclear Corporation (CER), tool pushers, and First Aid. The radiological protection trailers will be government-furnished through the Radiological Support Contractor (RSC). CER will furnish its monitoring system for effluent documentation (TRY-KRY System) installed in a trailer. Figure IIA-1 shows the trailer placement. LLL personnel will have access to two bunks in a house-type trailer. LLL and AEC will share office space in one trailer.

The flare stack will be located in the clearing to the northwest and above the EW, and the previously cleared cableway will become the process piping route. The area including the flare stack, process piping, storage and condensate tanks, separator, and wellhead equipment will be fenced with two-strand barbed wire to prevent livestock from entering the area.

The Grand Junction Control Point (GJCP) at the CER office and warehouse complex (Figure IIA-2) in Grand Junction will be maintained through the conclusion of the testing.

B. POWER INSTALLATION AND DISTRIBUTION

It will be necessary to reestablish the electric distribution cables and connections from the distribution panel to trailers and test equipment. Sufficient spare safety switches were initially installed to provide the following anticipated electrical demand.

	Drilling (KW)	Testing (KW)
RSC	40	40
AEC	10	10
LLL Biomedical	--	2
Tool Hands	5	--
Tool Pusher	5	5
CER	10	10
Area Lighting	10	10
TRY-KRY	30	30
Instrumentation	1	5
Water Injection Pump	--	50
Communications Equipment	5	5
Heat Tape	--	40
Total	116	187
Use Load Factor	0.8	0.8
Power Required	93	148

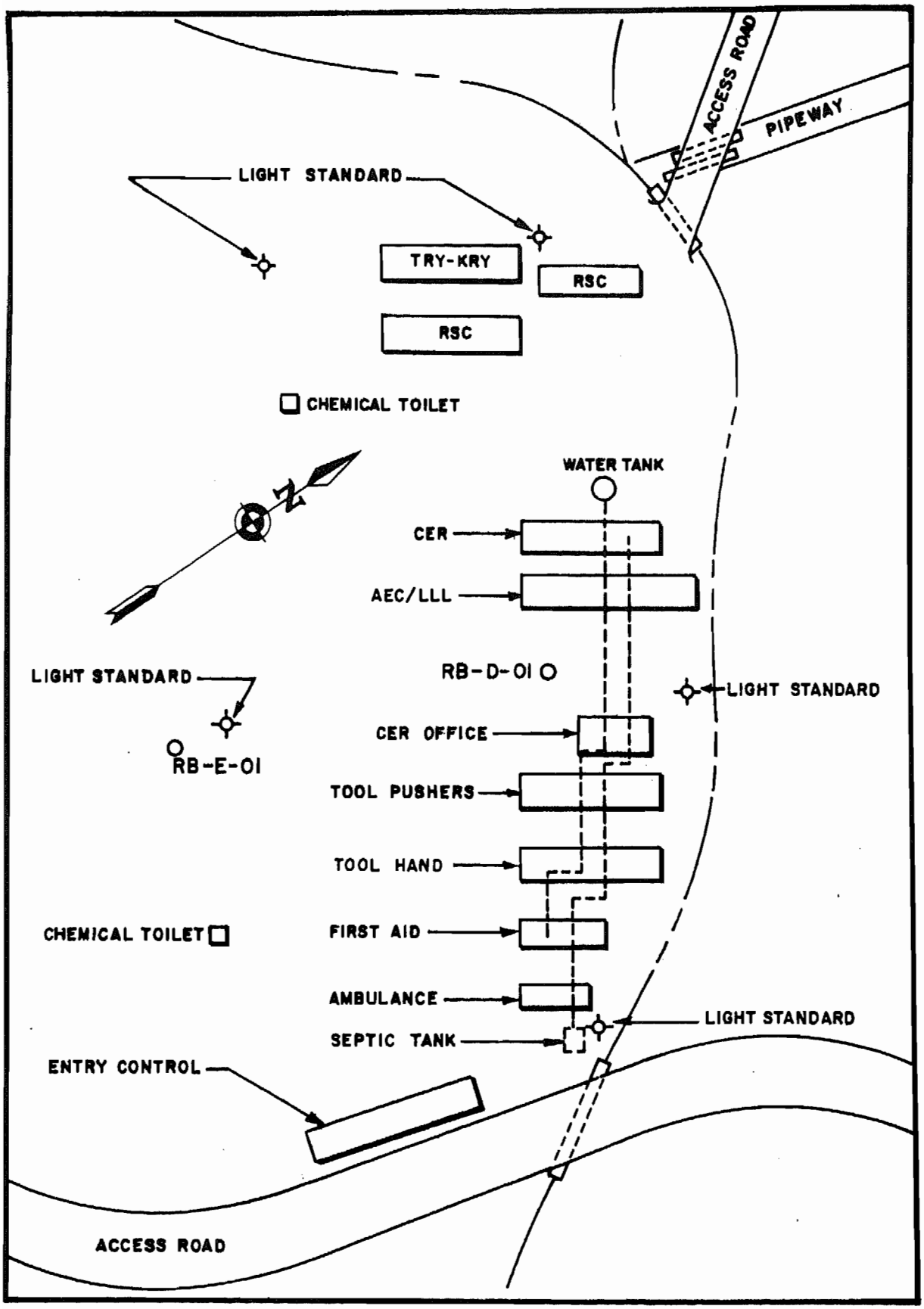

Figure IIA-1. Layout of trailers during reentry drilling and production testing.

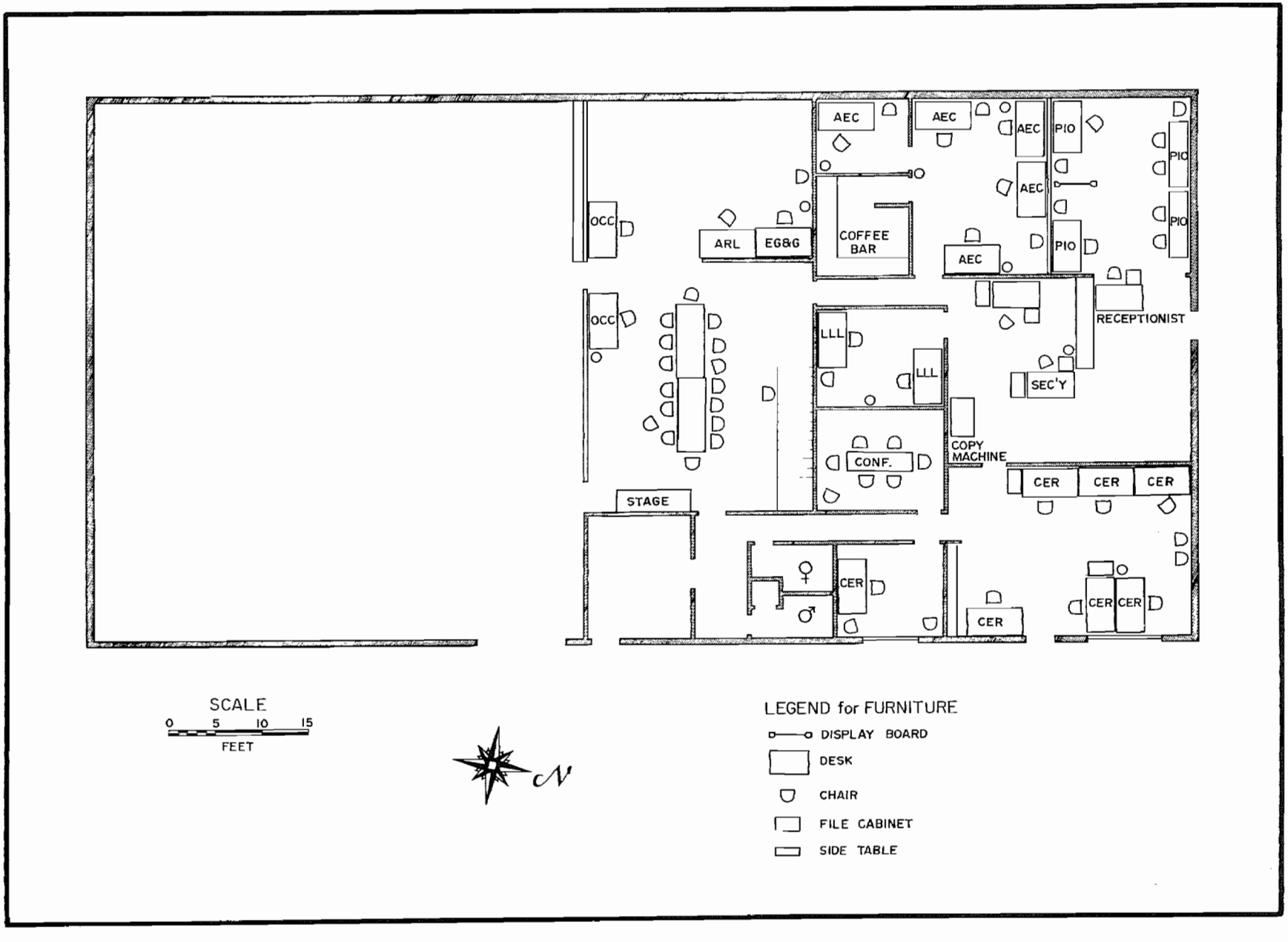

Figure IIA-2. Grand Junction office and warehouse complex.

An additional 50-kva, 3-phase transformer will be provided to supply power to the 50-horsepower water injection pump. This will increase the electricity provided to the EW to 150 kw (nominal).

Electric service from a commercial source will be available at the GJCP (Figure IIB-1).

C. COMMUNICATIONS

Telephone and radio communication facilities (Figure IIC-1) utilizing the project microwave communication equipment, identified in detail in Volume II, will be located at the GJCP where the telephone system will interconnect with the Mountain Bell telephone system.

Three telephone lines will originate in the Grand Junction telephone exchange, connect to the microwave equipment at the GJCP, and terminate at the EW. Individual telephone numbers will be assigned to each of the three telephone lines for direct dial access from the EW.

The microwave telephone relay stations will be located at Lands End, Monument Peak, and the terminal facility approximately 1/2 mile west of the EW. Signal cable laid for the detonation phase will connect the terminal facility to the EW to provide telephone service.

One duplex radio net will be utilized by all project participants. The repeater will be located on top of Monument Peak to provide coverage to mobile radios in the Piceance Creek basin. The control station for the EW will be located approximately 1/2 mile west of the EW with the microwave equipment and will be connected to the EW with signal cable.

One or both of the two remaining microwave channels can be converted to data channels to transmit data to the GJCP. One microwave voice channel will transmit a minimum of five data channels. Figure IIC-2 diagrams radio and telephone channels at the EW.

The GJCP will be furnished with telephones and radio as indicated in Figure IIA-2.

The frequencies of the radio net will be 153.35 MHz for repeater transmit and 158.37 MHz for repeater receive. These frequencies correspond to Net 2 as described in Volume II.

The frequency of the microwave system will remain the same as detailed in Volume II.

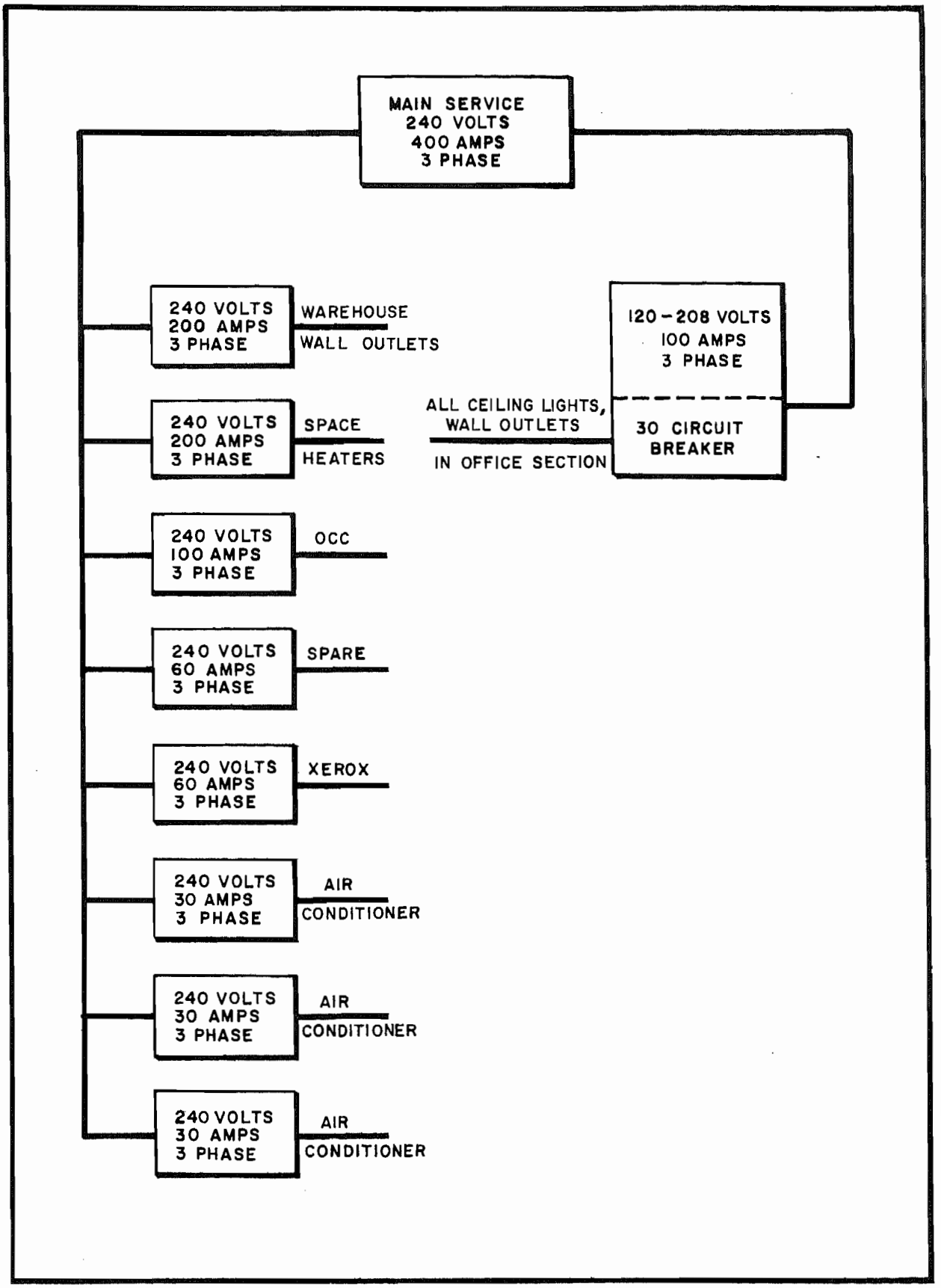

Figure IIB-1. Electrical service to GJCP.

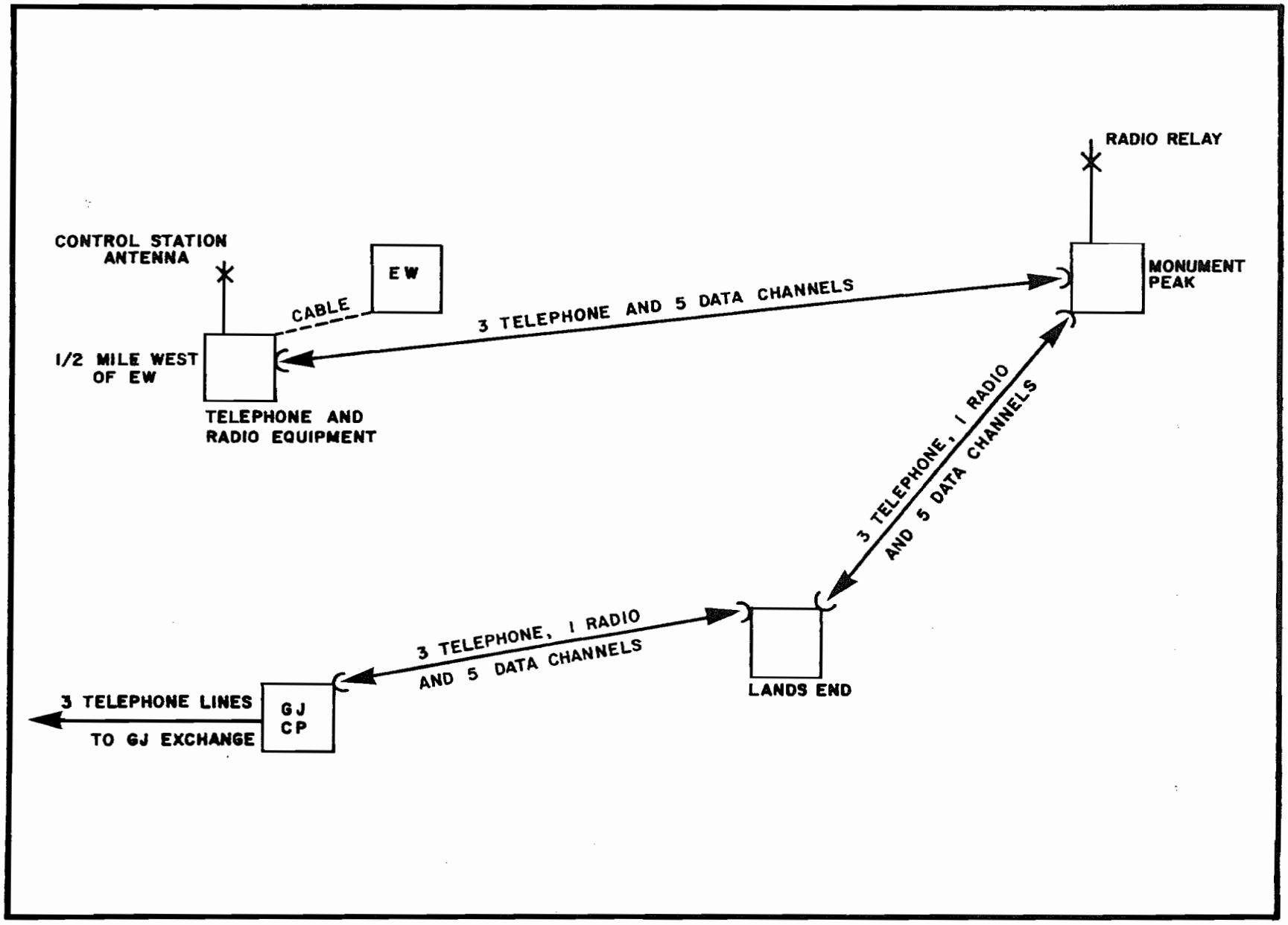

Figure IIC-1. Diagram of microwave, radio, telephone, and data transmittal system.

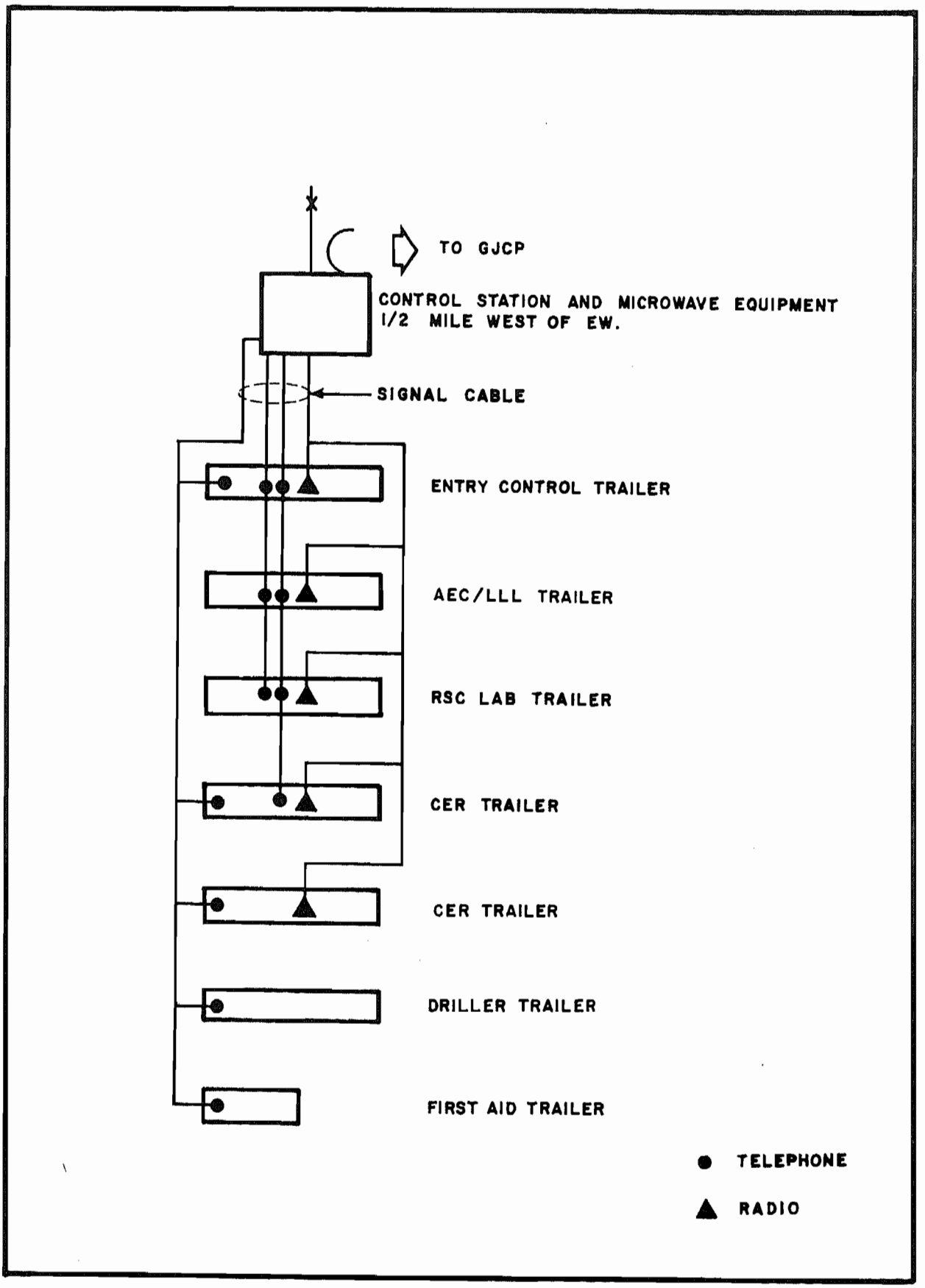

Figure IIC-2. Diagram of radio and telephone channels at the EW.

The mobile radio requirements will be:

Organization	CER Furnished Mobiles
AEC	8
LLL	3
RSC	2
CER	6
Total	19

A spare repeater will be available since only one radio net will be utilized.

D. INDUSTRIAL SAFETY

All operations and activities will be conducted in accordance with standards implemented under the Occupational Safety and Health Act of 1970 or those prescribed in AECM 0550, whichever provides the greater protection. CER will coordinate the health and safety activities of all participating agencies in the several project sites and will report any discrepancies in the activities of any agency not under its control to the AEC Project Director for corrective action.

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:

1. A safe and healthful environment for their employees.

2. Control and minimization of hazards to the public and to personnal of other participants.

3. Minimization of the accidential damage or loss of Government and privately owned equipment, materials, and property.

1. General Safety

Reentry of the stimulated gas zone will involve general construction work, drilling, and installation of high-pressure piping and pressure vessels. The following safety standards are established as criteria for the performance of this work:

(a) National Electric Code

(b) General Safety Requirements - Corps of Engineers

(c) ASME - Boiler and Pressure Vessel Code

(d) API - Recommended Standards and Procedures

(e) AAODC - Tool Pushers Manual

2. First Aid

CER will provide for an experienced first aid man and a radio-telephone-equipped ambulance, to be available on each work shift, for serving all project participants. If a driver is required in any emergency, CER will provide one from among project personnel. The first aid man will operate from a trailer, provided by CER, which is equipped with suitable first aid supplies as recommended by a local physician. CER will arrange for and supply medical supervision, as needed, by a local physician or physicians. CER 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.

At the completion of the flaring, activities warranting this service should be completed and it will be terminated.

3. Drinking Water, Fire Protection, and Sanitation

CER will reestablish these services as described in the Industrial Safety Section, Volume II.

E. GENERAL SUPPORT REQUIREMENTS

1. Labor Support

CER will provide a truck driver, carpenter, electrician, and miscellaneous labor to support the experiment.

Special skills will be needed to work on high-pressure piping and vessels and electrical and mechanical instrumentation systems.

2. Miscellaneous Purchases of Materials

All necessary supplies and equipment will be ordered far enough in advance to avoid delays and lost time. The remoteness of the project site precludes daily deliveries although CER will handle limited purchasing and transport material to the project site. Deliveries will be made on an as-needed basis.

3. Office Space and Miscellaneous Support

Office space will be provided for the following: AEC - Project Director, AEC Operations, LLL, CER, Conference Room, Public Information Area, and Secretary/Telephone Operator.

Secretarial and janitorial service will be provided for the office building. A copying machine will be available. A telephone operator will answer and route all incoming calls. Participants should supply their own letterhead stationery and other required special items.

Office equipment and supplies will be furnished at GJCP as listed below:

Bulletin Board	Cups, Paper, Drinking
Blackboard	Tablets, Salt
Typewriter	Ice (during summer months)
Adding Machine	Pen
Calculator	Pencil
Copying Machine	Chalk
Cabinet, Storage	Pen, Marking
Costumers	Eraser, Chalk
Waste Baskets	Paper Clips
Desk Lamps	Eraser, Pencil
Desk Trays	Eraser, Ink
Entrance Mats	Stapler
Paper, Bond	Staples
Paper, Scratch Pads	Ring Binder
Paper, Tissue	3-hole Punch
Paper, Carbon	2-hole Punch
Paper, Tablets, Ruled	Staple Puller
Paper, Copy Machine	Tape, Masking, 1/2 in.
Shovel, Snow	Tape, Masking, 1 in.
Rags	Tape, Masking, 2 in.
First Aid Kits	Tape, Filament, 1/2 in.
Paper, Towels	Paper, Wrapping
Paper, Toilet	Broom, Straight
Cans, Water, Insulated 5-gallon	File Folders
	Rubber Bands

Minimal office space will be provided in trailers at the EW as indicated below:

Organization	Size (Approx) (ft)
AEC/LLL	10 x 45
TRY-KRY	8 x 32
First Aid	8 x 25
CER	10 x 40
Tool Hands	8 x 40
CER	8 x 20

Janitorial service will be provided at the EW on a minimal basis, but no secretarial and clerical services will be available.

Office furniture will be supplied at the GJCP as shown in Figure IIA-2.

Drinking water will be furnished in cool cans at the EW.

Chemical toilets will be provided at the EW. Waste and garbage cans will be provided around the working areas at both the GJCP and EW. Disposal of refuse will be handled by an approved local agency.

Air conditioning will not be furnished to trailers at the EW. Trailers furnished by CER will be heated by propane fuel. Furnaces or heaters shall be of an approved vented type.

An emergency fuel and lubricating oil supply for vehicles and equipment will be furnished at the EW. All project participants should fuel their vehicles at a commercial supply (Meeker, Rio Blanco, Rifle, etc.) before coming to the forward area.

Approximately 1,200 square feet of enclosed warehousing is available at the GJCP office.

Limited enclosed storage will be used at the EW area for spare parts and equipment.

Sufficient open storage space is available at the GJCP and EW areas. Dust control, snow removal, and normal "good housekeeping" maintenance of the access road and EW area will be performed.

F. ROLLUP

At the conclusion of the experiment, the temporary facilities at the EW will be removed and only those items associated with a standard completed gas well will remain. These items are the well cellar, the wellhead equipment, fencing, and the deadmen for guying of the workover rig.

The piping, tankage, production equipment, flarestack, and other equipment required for the production testing of the well will be removed from the site and placed in storage at the Equity camp. Trailers will be returned to their owners or placed in storage at Grand Junction.

The communications equipment located at Monument Peak and Lands End will remain in place for future requirements. The remaining antenna towers, housing, and equipment will be stored at the GJCP. Other equipment, except for the weather recording stations (some of which will be relocated to collect data for future activities), will also be removed and stored at the GJCP.

The EW, FPCP, and weather recording station areas will be regraded to closely match the original contours and, at the appropriate time of the year, planted with grass to control dust and erosion. Any remaining drilling mud will be sprinkled on the access road and the mud pits will be backfilled.

Government furnished equipment made available to CER for the project will be returned to the government. The mobile radios, which were modified for the project, will be converted to their original frequencies and the Net 1 and 2 crystals returned to CER.

G. SCHEDULE

Figure IIG-1 shows the schedule for the major items taking place during the generalized site activities.

H. SUPPORT REQUIREMENTS

The normal utilities as well as various office supplies will be required. Secretarial service will be required at the Grand Junction office throughout this period.

1. CER Office Supplies and Equipment
2. GJCP Office Space
3. One 4WD Vehicle, w/Radio and Radio Phone

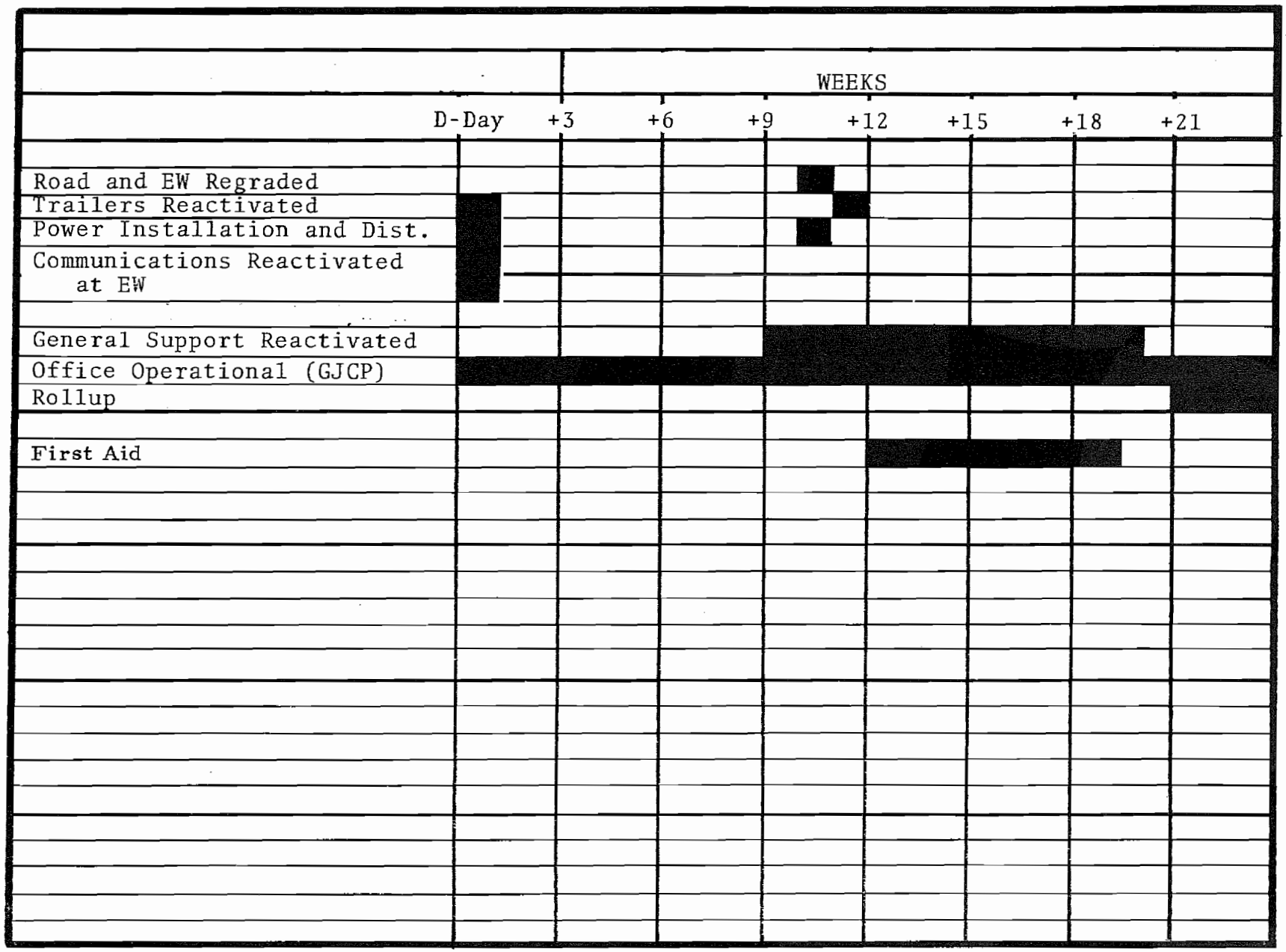

Figure IIG-1. Schedule for generalized site activities.

III. REENTRY PROGRAM (RB-E-01)

A. DRILLING PROGRAM

1. General

Reentry will be through the 7-inch emplacement casing using a downhole motor (Dyna Drill) and a 6-1/8-inch mill to drill out the cement plug inside the 7-inch casing from approximately 2,800 feet to approximately 5,200 feet. Drilling and/or milling will continue until communication with the chimney capable of producing a flow rate of approximately 20 to 30 MMSCFD is achieved.

If necessary, the drill string will be "snubbed" out of the hole. A retrievable production packer, equipped with a wireline retrievable plug, a short screened joint, and a short "rat hole" sub, will be lubricated into the hole on an electric line and set in the lower section of the undamaged 7-inch casing (5,200 to 5,700 feet) that had been water filled prior to detonation.

Tubing equipped with a wireline retrievable plug near the bottom will be run into the hole to approximately 45 feet above the packer assembly and landed in the wellhead. The containment equipment will be removed and the remainder of the wellhead tree will be installed and pressure tested. A lubricator and wireline equipment will be used to remove the tubing and packer plugs. A short flow test through the drilling well control (DWC) unit will be conducted to make sure of good communication with the chimney and then the rig and associated equipment will be moved off. The well and wellhead are then ready for connection to flow test equipment.

2. Surface Equipment and Services

a. Wellhead

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

Figure IIIA-1 shows the wellhead configuration for the period immediately following detonation. The cables have been pulsed and terminated but left long enough to be pulsed again if necessary. LLL is to machine the flange (item 4B) and furnish the necessary valves and tubing for the sampling system.

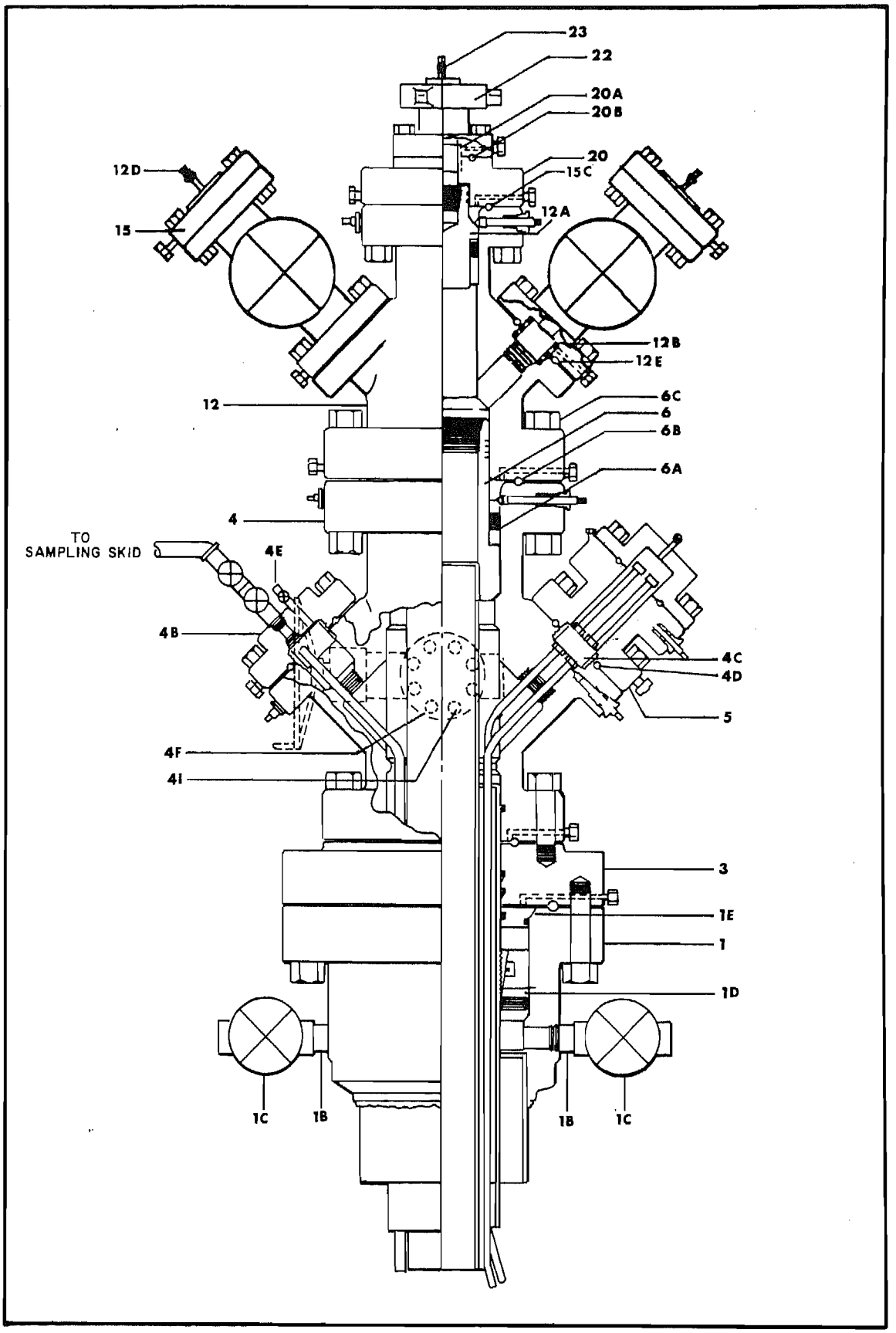

Figure IIIA-1. Wellhead configuration after postdetonation button-up and before reentry.

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DESCRIPTION OF NUMBERED ITEMS ON
FIGURES IIIA-1, IIIA-2, IIIA-3, and IIIA-4

Item	Description
1	Casing Head, Type C-29, 16" OD Slip-On & Weld W/Test Port Female Btm. x 16-3/4" 5000#WP (BX-160RG) Flanged Top W/ Two 2" LP Outlets (Ref. #E-9933)
1B	Nipples, Type XXN-5, 2" x 8"
1C	Valves, OCT Model 20 W/Trim "R", 2" x 1-13/16" 5000#WP, Reg. Port, S.E.
1D	Casing Hanger, Type C-22, 16" x 10-3/4"
1E	Seal Assembly, Type C-21, 16" x 10-3/4" W/ 0.500" OD LP Test Port and Hex. Plug
	Ring Gasket, API Metal, BX-162 (Not Shown.)
3	Adapter, Packoff, Type A-4-00 Double Studded, 10-3/4" OD W/ 16-3/4" 5000#WP (BX-162RB) Studded Btm. x 10" 5000#WP (R-54RG) Studded Top W/ Test Port in Btm.
	Ring Gasket, API Metal, R-54 (Not Shown.)
4	Head, Casing, Special Type C-29-L-00, 10-3/4" OD 5000#WP Flgd. Top & Bottom W/Two 4" 5000#WP Studded Outlets @ 45° W/Both Sides Counterbored for Cable Packoff. Prepared for Inner Seal Sleeve W/One 2" 5000#WP Studded Side Outlet @ 90° from 4" Outlets & Counterbored with Preparation for Inner Seal Sleeve & V.R. Threads (Ref. #L-5012 - S-2423 - E-9935)
4A	DELETED
4B	Blind Flange, 4" 5000#WP W/Btm. Bored for Inner Style #400-4 Seal Sleeve & Taped 1/2" LP T.P. in Side (Furnished by LLL.)

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4C LLL - furnished bulkhead connectors

4D Ring Gaskets, API Stainless Steel, R-39

4E Needle Valve, (Size & Type to Be Specified by LLL, California)

4F Valve, OCT Model 20W/ Trim "S", 2" x 2-1/16" 5000#WP Full Port F.E. Counterbored in Inlet Flg. for Style #200-4 Seal Sleeve & Test Port (Sim. Pt. #90-010-621)

Flange, Companion 2" 5000#WP x 2" LP (Not Shown.)

Bull Plug, Type B-4, 2" LP x 1/2" FPT (Not Shown.)

4I (1 Set) Studs & Nuts, Blk., 7/8"x6"

5 Tubing Head Assembly, SPECIAL Type "TC-P" 5000#WP, 4" 5000#WP Flanged Btm. x 4" 5000#WP Studded Top W/ Btm. & Top Counterbored W/Preparation F/Inner Seal Sleeve W/Test Port in Btm. (Ref. #9938)

5B DELETED

5C DELETED

5D DELETED

6 Hanger, Casing, Type C-29-FEN Fluted W/Extended Neck, 10" x 7" OD Buttress Female Top & Btm. Conn. (LLL Spec. 4330 Vanadium Modified Steel)

6A Packoff Assembly, Compression Type, Type C-29-FEN, 10" x 8.250" ID Complete F/ 400° F.

6B Ring Gasket, API Metal, R-54

6C Studs & Nuts, Blk., 1-7/8" x 13-3/4"

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12	Tubing Head, Assembly, SPECIAL Type "TCM-EN" 8.250" 5000#WP, 10" 5000#WP Flanged Btm. x 6" 5000#WP Flanged Top W/ Two 3" 5000#WP Studded Side 45° Outlets & V.R. Thds. W/ Preparation for Style #300-4 Inner Seal Sleeves in Outlets W/ Test Port in Bottom & Counterbored for Extended Neck Hanger.
12A	Tubing Hanger Test Plug for TC Head, 6" x 3-1/2" IF Drill Pipe Box on Top Only and W/ Extended Neck.
12B	Seal Sleeve Assemblies Type #300-4, 3" for 3" 5000#WP Outlets, Full Stainless Steel W/ Viton "O" Rings.
12C	DELETED
12D	Needle Valve, Type MF, 1/2"
12E	Ring Gaskets, API Stainless Steel, R-35
14	WKM 3" x 3-1/16", Series 1500 Power Seal Valves, Trimmed for High Temperature Service.
15	Flanges, Blind, 3" 5000 #WP W/ 1" FPT Tapped Hole & Counterbored for Style #300-4 Inner Seal Sleeve W/ Test Port
15A	DELETED
15B	DELETED
15C	Ring Gasket, API Stainless Steel, R-46
20	Adapter, Tubing Head, SPECIAL Type A-4-EN, 6" 5000#WP STUDDED Bottom x 2-1/2" 5000#WP Studded Top W/ Bottom Counterbored for 6" OD Extended Neck Tubing Hanger or Test Plug & Top Bored W/ Style #250-4 Seal Sleeve Complete W/ Two Test Ports @180°
20A	Seal Sleeve Assembly, Style #250-4, 2-1/2" for 2-1/2" 5000#WP Studded Outlet Full Stainless Steel, W/ Viton "O" Rings.

CHANGED 3/12/73

20B	Ring Gasket, API Stainless Steel, R-27
21	Valve, OCT Model 20, Trim "FB" 2-1/2" x 2-9/16", 5000#WP, F. E. Full Port Bored W/Seal Pockets In Each End W/ Test Ports
22	Adapter, Bottom Hole Test, Type B-15-A, 2-1/2" 5000#WP Flanged Bottom Bored W/ Style #250-4 Seal Pocket in Btm. Complete W/ Seal Cap & Nut W/ Viton Seal & 2-7/8" OD EUE 8RF Internal Lift Thread
23	Needle Valve, Type MF, 1/2"
25	Bottom BOP of Containment Stack Shown in Figure IIIA-3.

Figure IIIA-2 shows the wellhead ready for drilling operations. The blank tubing hanger plug (12A) and the top flange have been removed. BOP's and the remainder of the containment stack are assembled on top of the head. The blank tubing hanger plug will be utilized to test the drilling stack and BOP's during drilling operations. The wing valves have been installed and the cables terminated at the outlet and blind flanged. The sampling tube has been removed and the outlet plugged.

Item 25 on Figure IIIA-2 is the bottom BOP of the containment stack shown attached to the tubing head (Item 12) in Figure IIIA-3.

Figure IIIA-4 shows the final wellhead configuration ready to hook up for testing. Flow will be up the annulus between the 7-inch casing and the 2-7/8-inch tubing. Instruments will be suspended on wireline or cable inside the 2-7/8-inch tubing.

b. Containment Equipment

The containment equipment or drilling stack employed during reentry drilling operations is shown on Figure IIIA-3. The stack sets on top of the tubing head (Item 12) shown in Figure IIIA-2 during the actual drilling. 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 test pressures of 10,000 psi. Certifications will be obtained from the testing company, and a CER and an AEC representative will witness the tests. Field tests of the drilling stack will be conducted to 3,000 psi which exceeds the expected surface pressure by approximately 500 psi. 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 5-inch OD drill collars, and pressuring above this plug with liquid to test the individual rams of the BOP equipment.

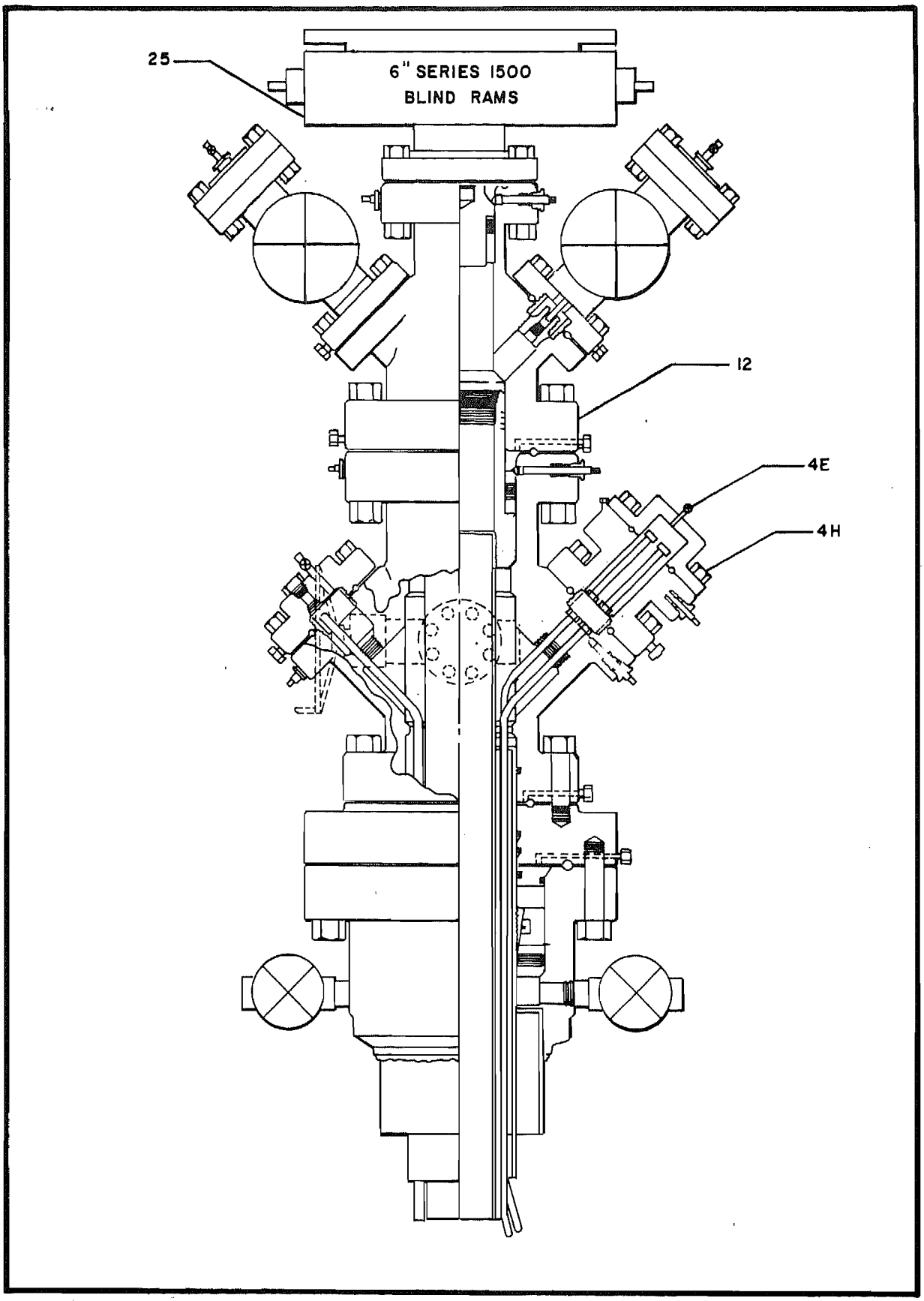


Figure IIIA-2. RB-E-01 wellhead status for reentry drilling operations.

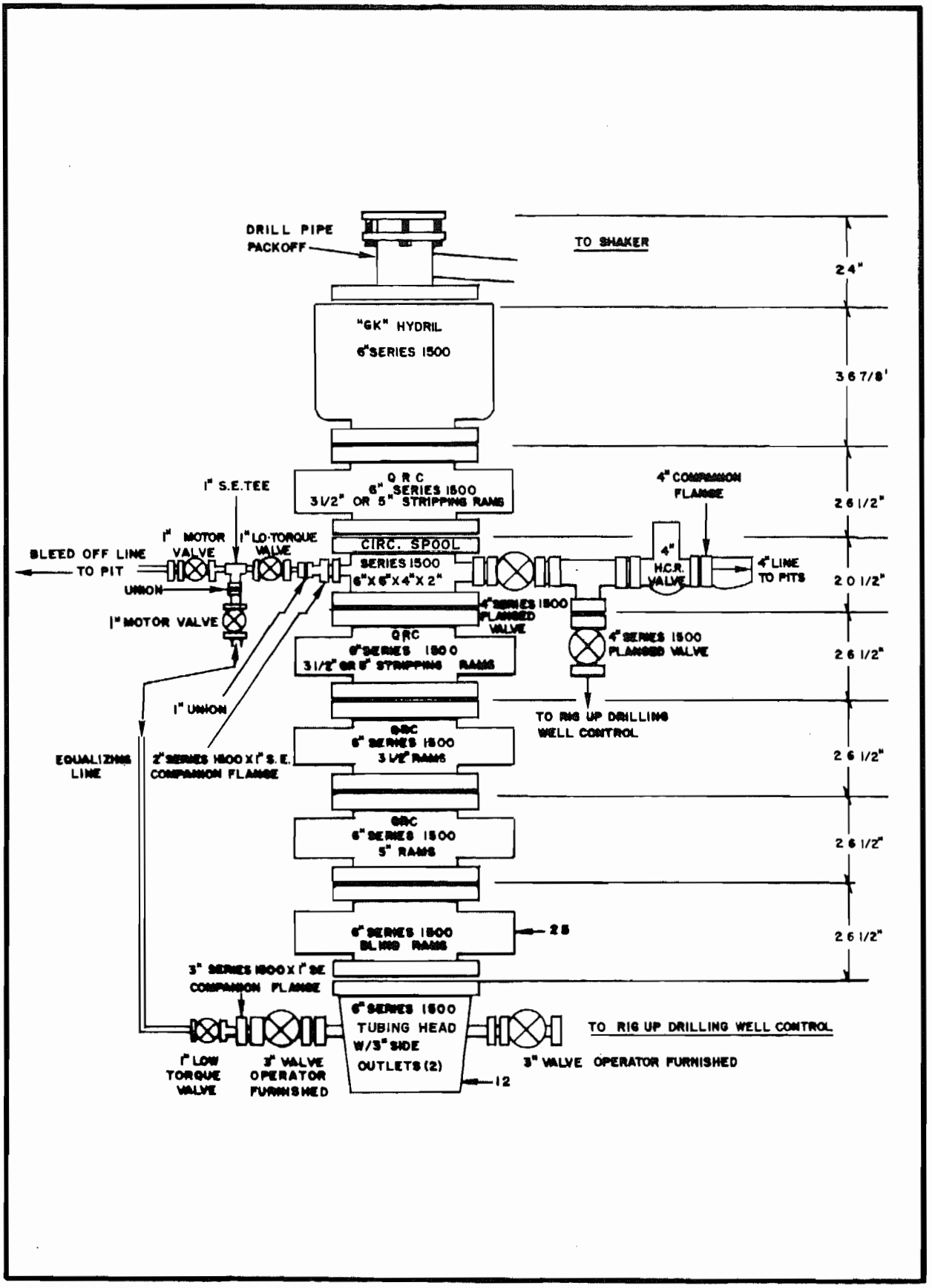


Figure IIIA-3. Blowout preventor snubbing stack for reentry.

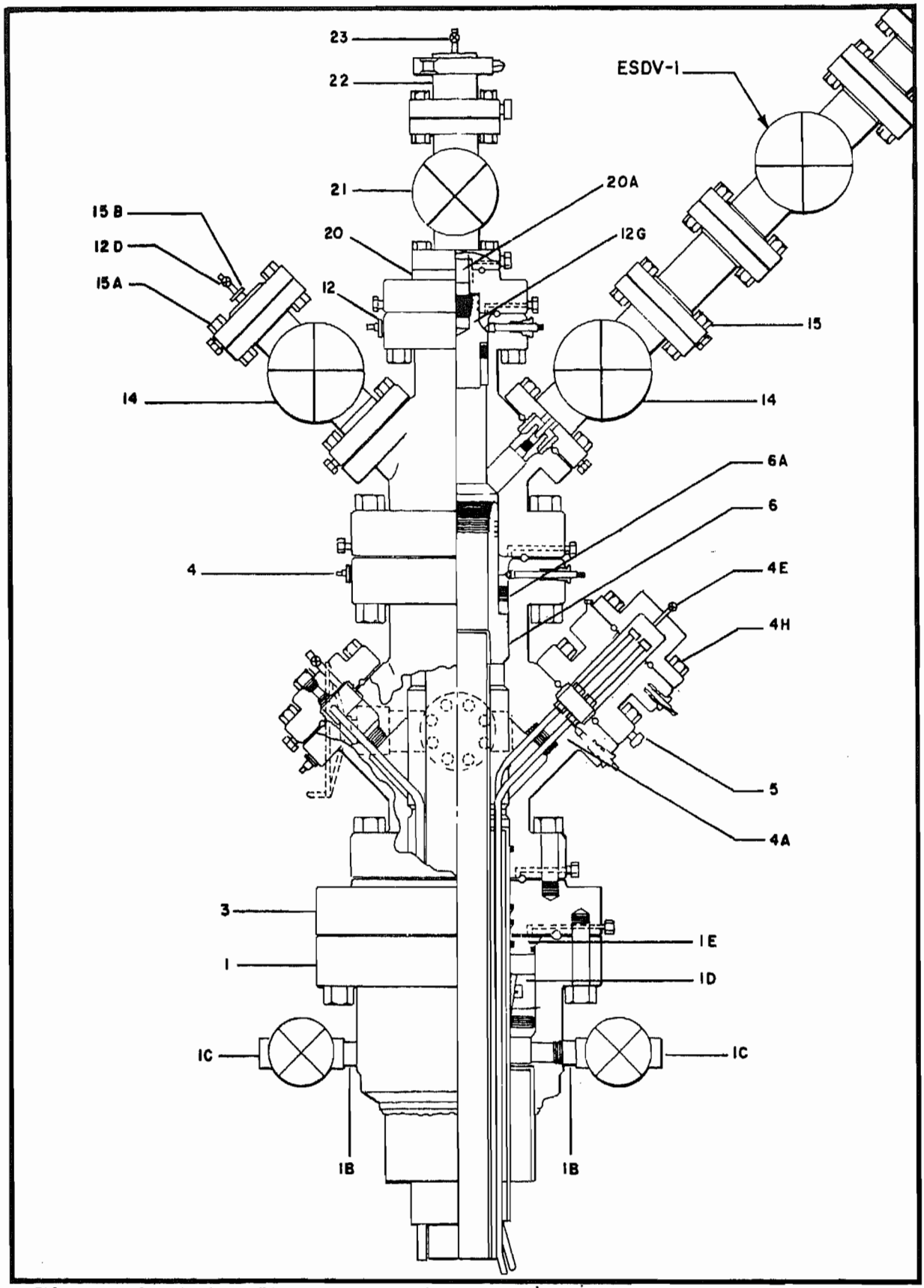


Figure IIIA-4. RB-E-01 wellhead status following reentry and ready for connection to test equipment.

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.

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 approximately 21 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 IIIA-5.

d. Drilling Recording Instruments

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

(1) Mud weight in and out of the hole.

(2) Pit volume indicators with alarms to determine changes in mud volume.

(3) Drilling time, depth, penetration rate, and hook load will be recorded.

(4) Pressure recorders to indicate pump pressure and return-line pressures.

e. Snubbing Equipment

Otis Tool Company snubbing equipment with qualified personnel will be on location ready for operation as required. A general schematic of the snubbing equipment is shown on Figure IIIA-6. The figure only shows the equipment required for snubbing and does not show all of the BOP equipment. The equipment shown in Figure IIIA-6 attaches to the top of the BOP stack shown in Figure IIIA-3, if required.

The snubbing equipment consists of a set of traveling snubbers, used to force the pipe into or out of the well against the closed well pressure, and a set of stationary snubbers, which prevent the pipe from being blown from the well while the traveling snubbers are being raised or lowered for a new bite on the pipe. A snub line passing over the center sheave of the traveling block and under the sheave of the snub block clamp

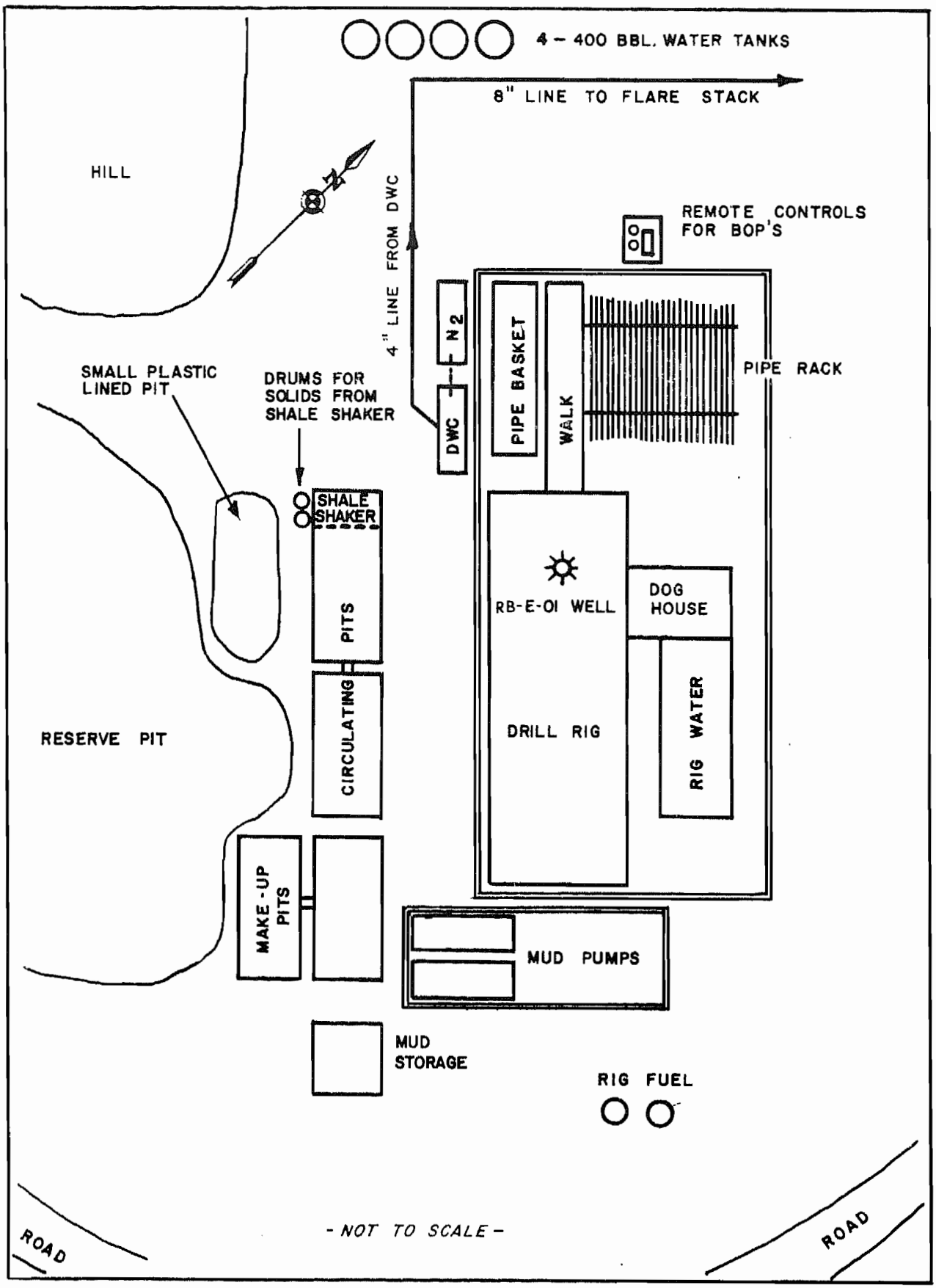


Figure IIIA-5. Schematic drawing of drill rig layout for reentry of RB-E-01 well.

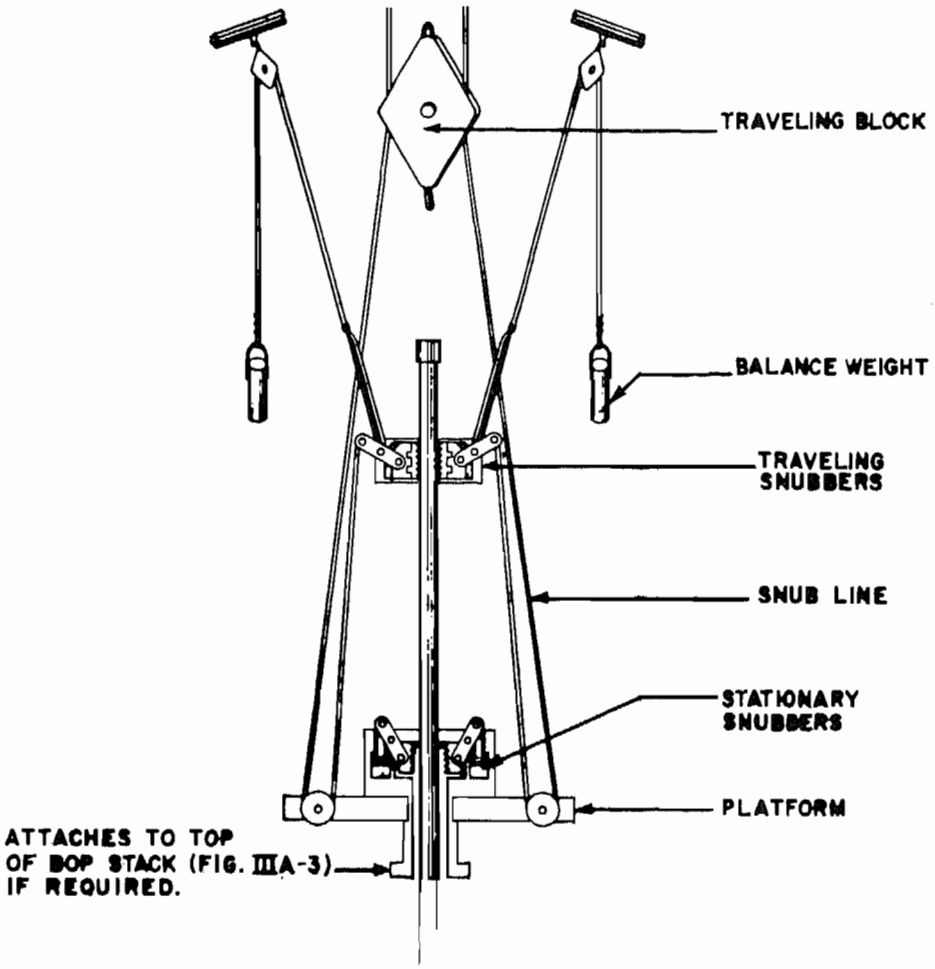


Figure IIIA-6. General schematic of snubbing equipment.

to the handles of the traveling snubbers transmits a balanced pull downward to the traveling snubbers as the traveling block is raised. Therefore, there is no tendency to bend the pipe by pulling more on one side than on the other. Balancing weights automatically raise the traveling snubbers for a new grip on the pipe when the traveling block is lowered..

The stationary snubbers are bolted to the upper control head. The snubbers are so constructed that once they have taken hold of the pipe, the greater the upward force, the tighter the grip on the pipe.

The control manifold, used to operate the control heads and the stationary snubbers, is then rigged up at a convenient spot so that the control manifold operator may oversee and supervise the entire operation.

The drilling stack is designed to allow for the removal of all downhole drilling tools and equipment if snubbing out under pressure should be required.

Even though the Dyna Drill assembly and bit are 23.9 feet overall, the upper portion of the assembly is the same OD as the collars and can be "snubbed" out in the same manner as the rest of the drill string. The bottom portion of the Dyna Drill and the bit are larger than the string and the preventer stack has been designed to allow removal under pressure of the bottom 9.3 feet of the assembly that has the larger OD.

f. Drilling Well Control Unit

A fully tested and assembled DWC unit will be on location and ready for use in case gas is being returned in the circulating drilling mud. The DWC unit will be a two-stage (high-pressure and low-pressure) unit and will receive the mud returns from the drilling stack. The gas will be discharged to the flare stack. The mud is then returned to the circulation tank for reuse.

Personnel will be available to operate the DWC unit when needed.

A complete description of the DWC unit follows:

(1) The Inlet Manifold

The inlet manifold consists of two 2-inch steel adjustable chokes and a bypass, all rated to 10,000-psi working pressure. The high-pressure line from the

wellhead assembly is tied into the inlet manifold, and the inlet manifold discharges well fluid into the high-pressure vessel through the appropriate valving.

The inlet manifold may be used to take the first pressure drop from the well through steel chokes in the event this pressure exceeds the working pressure of the high-pressure well-control vessel.

(2) The High-Pressure Well-Control Vessel

The high-pressure vessel is constructed of SA212-B steel, 1-1/2-inches thick, and is rated to 1,200-psi working pressure, 1,800-psi test pressure. The vessel is 7-feet, 2-inches high with a 36-inch diameter. It is equipped with two safety devices; a 1,320-psi bursting plate and an automatic pop-off valve designed to open at pressure slightly less than 1,320-psi. The vessel is usually operated at 1,000-psi or less.

One function of the vessel is to receive well stream fluid from either the discharge side of the choke manifold or directly from the well. Another function of the vessel is to act as a surge chamber to reduce the shock loadings on the wellbore that may occur as a result of rapid changes in back pressure. The presence of a compressible gas in the vessel plus the vessel's tolerance to considerable foreign material that will normally cause plugging in an adjustable choke contribute to its unique value for pressure control. Any free gas associated with the well stream is flared as excess from this vessel. The high-pressure vessel will take either the first pressure drop directly from the well or the second drop downstream from the choke, depending on well pressure. The vessel is capable of handling a liquid volume of approximately 17,000 barrels per day while flaring gas at a daily rate of 12 MMSCFD, with 800-psi vessel pressure.

(3) The Low-Pressure Vessel

The low-pressure vessel is constructed of SA212-B steel with shell, head, and base thicknesses of 1/4 inch, 3/16 inch, and 1/2 inch, respectively. It is rated at 125-psi working pressure and 188-psi test pressure. The vessel is equipped with two safety devices; a 138-psi bursting plate and a shear pin pop-off valve set slightly below 138-psi.

One function of the low-pressure vessel is to take the second or third pressure drop (depending upon whether or not the well stream is passing through the chokes in the inlet manifold or going directly into the high-pressure vessel). Another function is to reduce the well stream to atmospheric pressure and discharge it into a tank or into the circulating system of the well. The remaining free gas that flashed in the pressure reduction occurring between high- and low-pressure vessels is flared from the low-pressure vessel.

The low-pressure vessel is generally operated at the minimum pressure level that will permit handling the complete well stream being fed from the high-pressure vessel. This maximizes the removal of entrained gas in the well stream which, in case of a well control operation, minimizes gas cutting of the mud. Vessel pressure requirements will vary also, depending upon the height the fluid has to be lifted prior to discharging into the receiving tank or mud system.

The low-pressure vessel is capable of flaring a maximum of 4.5 MMSCFD when operating at 100 psi and utilizing a 2-inch line to the flare.

(4) DWC Unit Accessory Equipment

(a) Dump Valves and Liquid-Level Controllers

The DWC unit is equipped with two high-pressure dump valves and one low-pressure dump valve.

These dump valves are the normally-closed, diaphragm type and are opened by supply pressure from liquid-level controllers on the vessels. The liquid-level controller consists of a float arm and a control mechanism made up of a ball and spring on a small orifice or a diaphragm and peanut valve located on the outside of the vessel. The float arm extends through the wall of the vessel to the control mechanism. Each vessel is equipped with two liquid-level controllers, one to operate the dump valve and one to operate a high liquid-level warning device (horn).

(b) Vessel Pressure Regulators

The excess gas vent lines from each vessel are equipped with diaphragm-type pilot-operated

pressure regulators to maintain vessel pressure, thereby controlling the back pressure required for proper well control. These regulators, which are normally open when not in use, are held closed by supply pressure from the console control mechanism. When vessel pressure reaches the predetermined level, the control mechanism will remove air pressure from the diaphragm, thus allowing the valve to open and vent gas.

(c) Gas Meter

A 3-inch Daniel Senior-Orifice meter, located on the high-pressure vessel flare line and equipped with a Barton recording meter, is designed to meter gas from the high-pressure vessel at maximum flow rates.

(5) Equipment Control

The control panel, which is normally used to control various equipment on the unit, is not skid mounted but is positioned on a stand at a convenient location near the well control unit. One function of the panel board is to assemble at one location all the gauges, controls, etc. necessary to operate the unit.

g. Explosimeter System

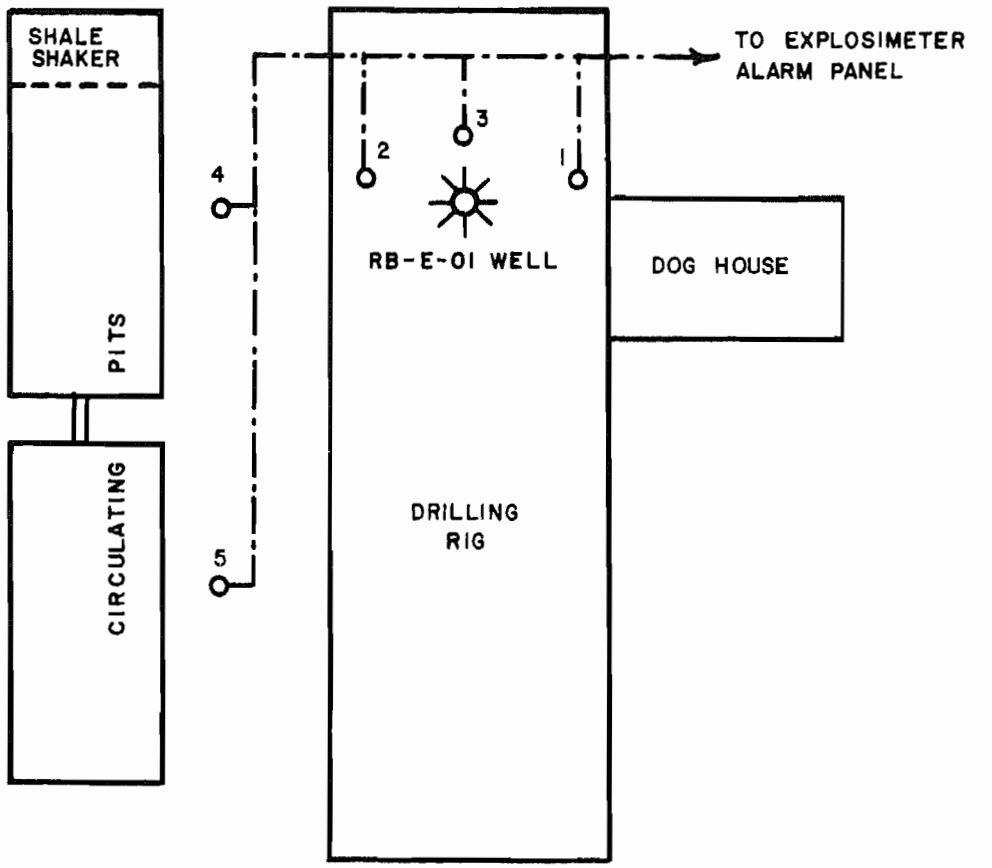
An explosimeter system (Mine Safety Appliance Co. Model I-500 Combustible Gas Detection System) will be installed and tested prior to starting reentry drilling. The system will utilize five remote sensing heads around the rig and transmit the data from each individually to a control point at the TRY-KRY Trailer. Each sensing head will be capable of sounding an alarm to indicate the presence of a potential explosive mixture.

Two of the remote sensing heads will be located on the rig floor, one will be located under the rig floor, and two located between the circulating mud pits and the rig. The locations of the various heads are shown in Figure IIIA-7.

A spare sensing head will be on location.

h. Flareline, Stack, and Purge System

The flareline and flare stack will be in place and ready to use when reentry drilling operations begin. The flareline will



EXPLOSIMETER MONITORING HEADS

1 & 2 - LOCATED ON RIG FLOOR

3 - LOCATED UNDER RIG FLOOR NEAR DRILLING STACK

4 & 5- LOCATED BETWEEN CIRCULATING PITS AND RIG

Figure IIIA-7. Explosimeter system for reentry of RB-E-01 Well.

receive gas from either or both stages of the DWC unit and move the gas away from the rig where it will be burned as it exits from the stack. The schematic flow diagram of the flareline and purge system is shown in Figure IIIA-8.

The stack will be equipped with a pilot light capable of being remotely ignited. The stack will also extend high enough above the ground and be located far enough from personnel to prevent damage to equipment and injury to personnel from radiant heat.

Natural gas from the Fawn Creek Government No. 1 Well will be used for the purge system installed on the flareline to the stack to prevent an explosive mixture from accumulating in the stack and/or flowline.

3. Downhole Equipment and Services

a. Casing and Tubing

Casing: Reentry will be accomplished, if possible, through the inside of the 7-inch emplacement casing described in Volume II.

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.

Tubing specifications:

Size (OD)	2.875 inches
Weight/ft with coupling	6.50 pounds
Grade	J-55
Drift diameter	2.347 inches
Coupling (OD)	3.668 inches
Collapse resistance	6,800 psi
Internal yield pressure	7,260 psi
Joint yield strength	99,660 pounds

b. Drill Pipe and Drill Collars

The drill string used for reentry 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. A power swivel equipped with an inline safety valve will be utilized to suspend and slowly rotate the drill pipe while drilling with the Dyna Drill.

The drill collars will be approximately the same size as the Dyna Drill (approximately 5 inch OD) used

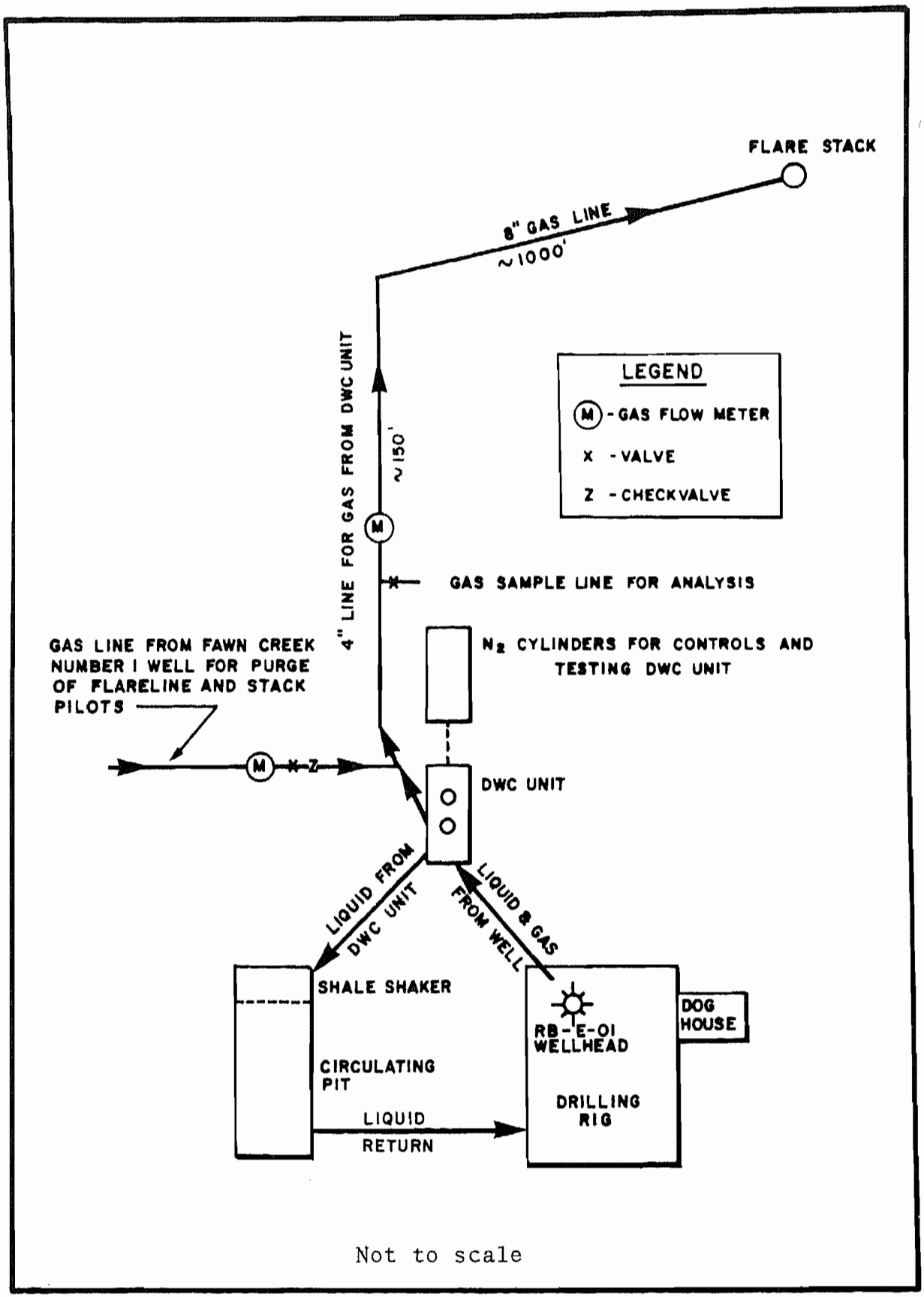


Figure IIIA-8. Schematic diagram of flareline and purge system for reentry of RB-E-01 well.

for reentry drilling. The drill string will also include a float valve just above the mud motor and a short nipple above the float collar to receive a retrievable wire-line plug run inside of the drill string. The drill collars will be magnafluxed prior to running into the hole.

c. Downhole Drilling Motor

The mud motor used downhole for drilling cement and milling will be a straight-hole-type Dyna Drill. Motor OD will be 5 inches. Overall length of the tool is 23.9 feet. The lower 7.7 feet of the tool is 5-1/4 inches in OD and is the bearing and drive shaft assembly section of the motor. The drilling stack has been designed to allow removal of this section and the drilling bit during snubbing operations, if required.

d. Drilling Bits or Mills

Mills designed for use in drilling cement inside of cased holes will be employed to drill the cement plug inside the 7-inch casing from approximately 2,800 feet to approximately 4,700 feet. A junk mill will be utilized to drill the bottom 500 feet of cement plug. Junk mills will be used to mill damaged casing, if required.

e. Drilling Fluids

Water will be used to drill the cement plug inside the 7-inch casing. Use of water will eliminate treatment of cement contaminated mud during much of the drilling operation. Conversion to a gelled water system will be done at approximately 4,700 feet or approximately 500 feet before reaching the bottom of the cement plug inside the 7-inch casing. Treatment of the mud to prevent "fluffing" by cement will be required. Weight material (barites) will be added as needed so that the mud column weight will be nearly the same or slightly exceed the expected chimney pressure of 2,600 psi.

Drilling mud will be mixed and maintained in two separate mud storage systems. One system will be utilized for drilling and may become slightly contaminated. The monitoring of the mud system for radioactivity is described in Section VA. The second system would be used as a makeup to the drilling system and would at all times contain fresh drilling mud. After communication is established with the chimney,as much as possible of the contaminated mud will be pumped downhole to maintain a slightly over-balanced condition downhole while

rigging up for snubbing operations. Any remaining contaminated mud would be displaced with uncontaminated mud and pumped into the chimney before snubbing out of the hole and prior to the well completion operations. The remaining uncontaminated drilling mud would be disposed of by spraying the mud on the roads during dry weather and/or by placing the mud in an earthen pit, allowing the mud to dehydrate, and then covering it with dirt.

4. Drilling Procedure

a. Pressure test the 7-inch casing to 1,000 psi using nitrogen. Bleed off pressure.

b. Move on drilling rig and associated equipment, and rig up.

c. Attach a gauge to the wellhead and ensure that pressure is zero psig inside the 7-inch casing. Install drilling stack and pressure test individual components to 3,000 psi. Ensure that BOP controls on rig floor and remote controls function correctly.

d. Install and hook up the DWC unit. The DWC unit representative will demonstrate the correct functioning and operation of the unit. Tests will be witnessed by a CER and an AEC representative.

e. Test operation of flareline, stack, and purge system using gas from Fawn Creek Government Number 1 Well. (Most of this system will be installed prior to moving on rig.)

f. Connect circulating system and mix mud in makeup or standby system. Place water in circulating system.

g. Ensure correct operation of recording instruments and alarms related to the drilling liquids systems after pits are at working levels and mud has been mixed.

h. Check functioning of explosimeter system to ensure their correct operation and that alarms are working.

i. Ensure that all personnel, equipment, spare parts, and equipment related to reentry are on location and ready. Ensure that checklists for periodic operation of surface equipment are available and complete and that their application is understood by persons concerned.

j. Run a 6-1/8-inch mill for drilling cement on a 5-inch Dyna Drill, and 5-inch drill collars with a float immediately above the Dyna Drill and a plug receiving nipple immediately above the

float. Run in the hole with 3-1/2-inch IF drill pipe to approximately 1, 000 foot depth, and check operation of Dyna Drill, pumps, and the inline safety valve. Run and test the retrievable plug in the drill string. Retrieve the plug. Check operation of pipe ram-type BOP's and the Hydril.

k. Tag top of cement. Drill cement from 2, 800 to 4, 700 feet feet using water. Trip out and put on junk mill. Clean cement cuttings out of mud pits.

l. Mix mud and ensure makeup mud pits, circulating mud pits, and hole are full of mud before proceeding.

m. Check operation of equipment again, as in step 4j. Correct any problems prior to drilling ahead.

n. Drill remainder of cement plug (approximately 500 feet) inside of 7-inch casing using junk mill. Treat mud to prevent fluffing.

o. If lost circulation occurs but good communication with the chimney is doubtful, mill ahead until communication is obtained.

p. After completing step 4n and communication with the chimney is confirmed, drill ahead three joints (approximately 90 feet). Attempt to maintain slight hydrostatic overbalance. Use contaminated mud first to maintain overbalanced condition.

q. Pump all remaining contaminated mud down annulus and displace to bottom of hole with uncontaminated mud. Attempt to maintain a slight hydrostatic overbalance while coming out of the hole.

r. Displace mud in drill pipe with water, run wireline plug, and set in plug receiving nipple. Snub out of hole, if necessary.

s. After snubbing the drill string out of the hole, lubricate the downhole packer assembly (Figure IIIA-9) in the hole on an electric wireline. The packer assembly is made up of the following components:

(1) A wireline set, retrievable, production packer.

(2) A plug receiving nipple below the packer with a wireline retrievable plug installed.

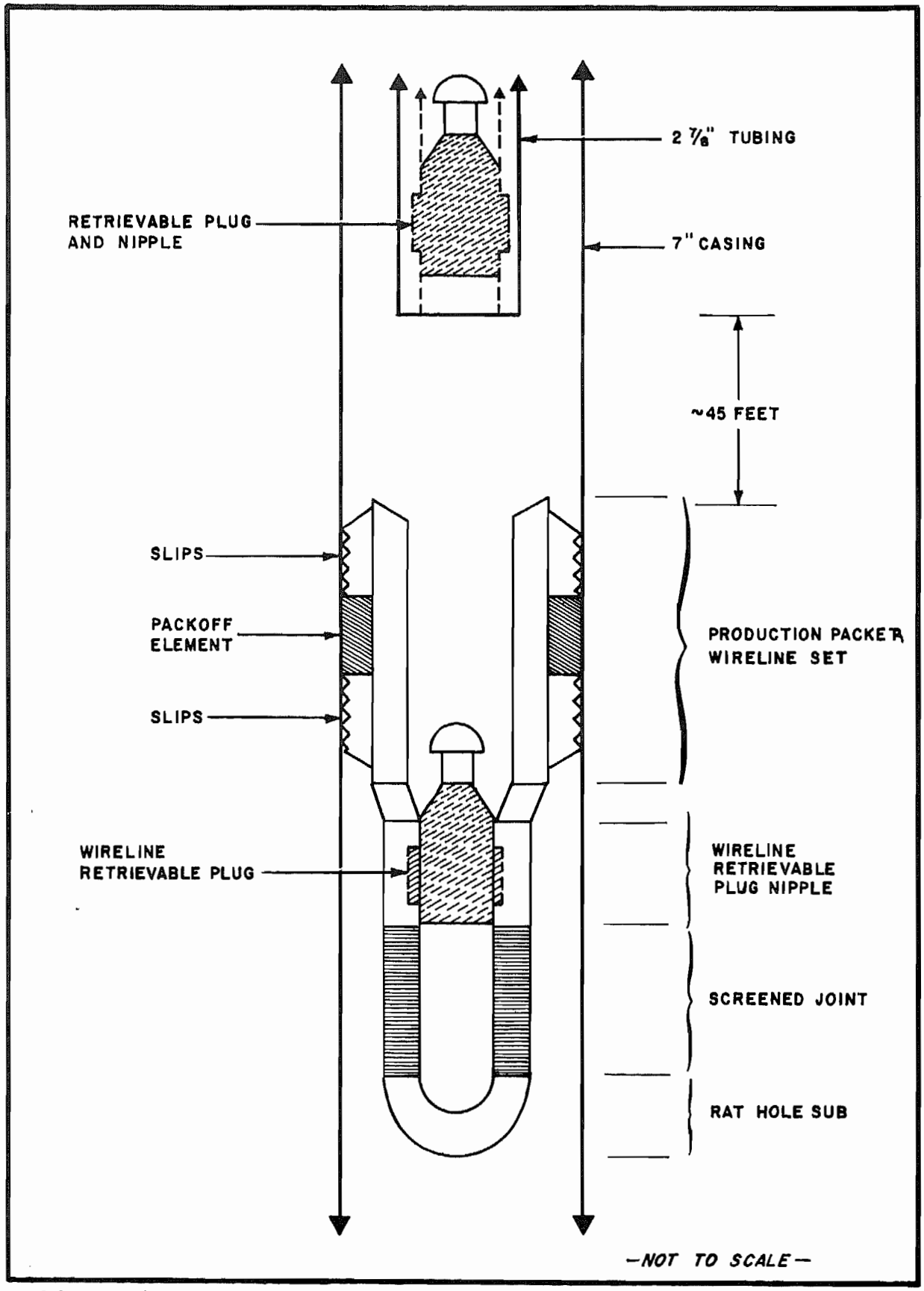


Figure IIIA-9. Schematic drawing for the packer assembly for reentry and completion of RB-E-01 for testing.

(3) A wire-wrapped screen joint below the plug nipple.

(4) A short plugged joint (rat hole joint) below the screen joint.

The packer assembly will be set, if possible, in the uncemented section of the 7-inch casing just above the top chimney (approximately 5,500 feet). After setting the packer, the pressure below the packer is contained and any gas pressure above the packer will be bled off to the flare stack through the DWC unit. The casing will then be filled with water. A schematic of the final downhole completion is shown in Figure IIIA-10.

5. Completion Procedure

a. Install 2-7/8-inch tubing rams in the stripping BOP and standard BOP. Pressure test the rams to 3,000 psi before running the tubing.

b. Run and land 2-7/8-inch tubing approximately 45 feet above packer assembly. The tubing will be run with a wireline retrievable plug installed in the bottom joint. Fill tubing with water periodically while running.

c. After landing tubing and locking the tubing hanger in place, fill tubing with water, remove BOP stack (Figure IIIA-3), and install wellhead master valve and lubricator. Test tubing-head seals to 3,000 psi using a hydraulic handpump.

d. Connect the DWC unit to one of the wellhead wing exit valves of the 2-7/8- x 7-inch annulus. Pressure test the line from the wellhead to the DWC unit to 3,000 psi using liquid.

e. Retrieve wireline plug from 2-7/8-inch tubing. Run in with fishing head and retrieve plug from the packer assembly. Pull into lubricator, close master valve, rig down lubricator, and install companion flange with 1/2-inch needle valves on the tubing head valve and wing valves.

f. Allow wellhead pressure to stabilize after liquid in wellbore drains into chimney. Flow the well to the flare stack through the DWC unit at a rate of approximately 7.5 MMSCFD. Observe and record 2-7/8-inch tubing pressure to verify communications with the top of the chimney. Flow period is expected to be for approximately 2 hours. Initial gas samples will be obtained for analysis during the 2-hour flow period. (Refer to paragraph VA-1h for constraints on releases of radioactivity.)

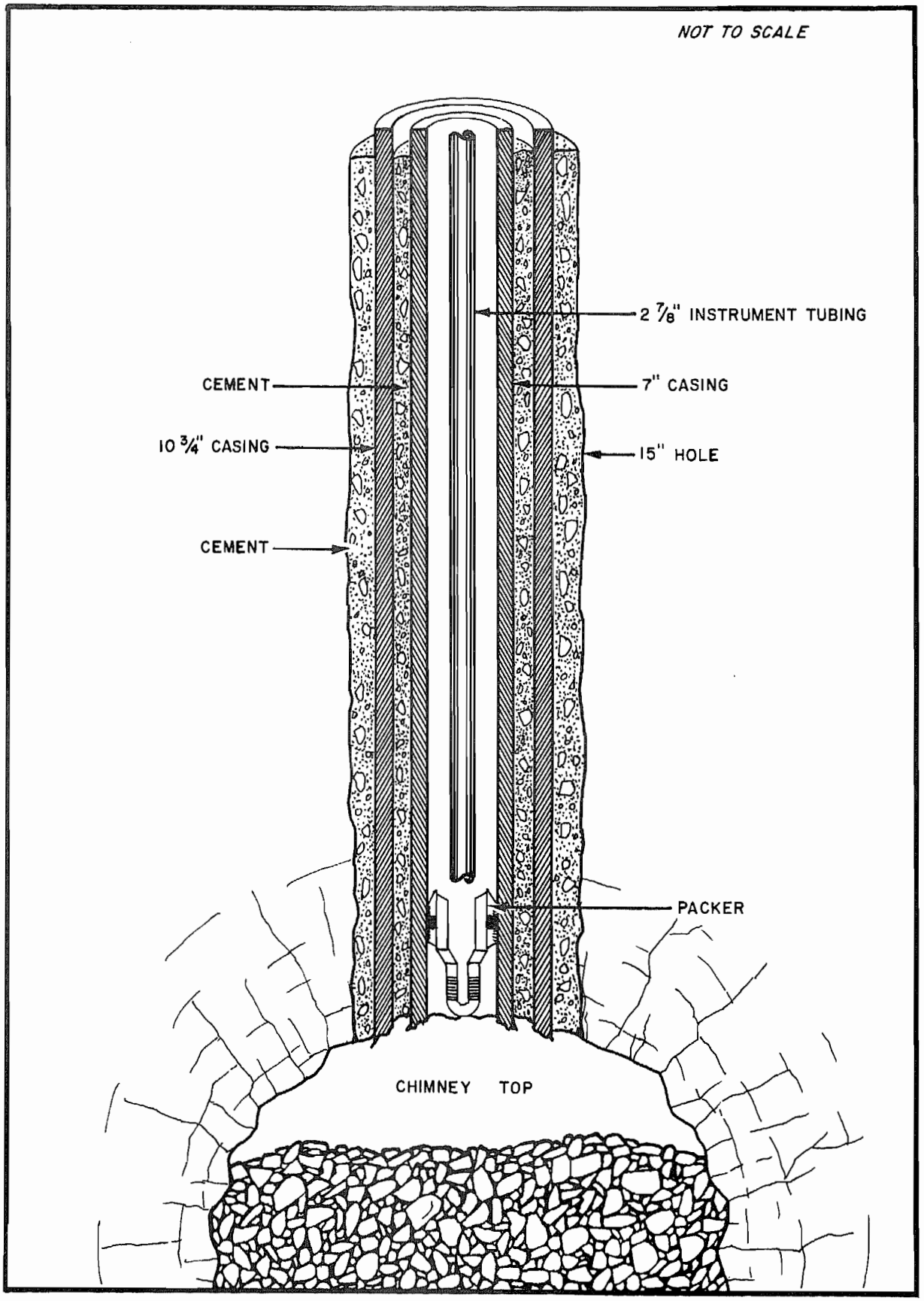


Figure IIIA-10. Downhole completion plan for RB-E-01.

g. Release and move off rig and associated equipment. Clean up location and rig up equipment for production testing.

B. ALTERNATE REENTRY PLAN NUMBER 1 (Sidetrack Out of RB-E-01)

If a successful reentry cannot be accomplished through the 7-inch casing and the cause is in the lower portion of the hole, a whipstock and directional controlled drilling technique may be employed to reach the chimney (Figure IIIB-1). Some problems exist with taking this approach and are primarily related to the following:

1. Need to mill (underream) a section through two strings of casing (7 inch and 10-3/4 inch). This takes a special tool.

2. Potential drilling or milling problems with cables on outside of the 7-inch casing, although these should be set in cement.

3. Potential problem with centralizers around 7-inch casing; these too should be set in cement.

4. The gas sample tube will need to be plugged downhole prior to milling window in side of casing.

5. Hole size will limit liner size to 4-1/2- or 5-inch flush-joint pipe.

If the decision is made to sidetrack out of the RB-E-01 well, the general procedure would be as follows:

1. Set a short cement plug or bridge plug inside the 7-inch emplacement casing above the problem area to cut off any possible communication with the chimney.

2. Mill out a section of the 7-inch and 10-3/4-inch casings.

3. Set a cement plug in the opened section.

4. Whipstock out of original hole.

5. Control direction and deviation, and drill to just above expected fracture zone.

6. Set a 5-inch flush-joint liner and cement in hole. Clean out cement at top of liner and pressure test.

7. Drill out bottom of liner and into communication with chimney.

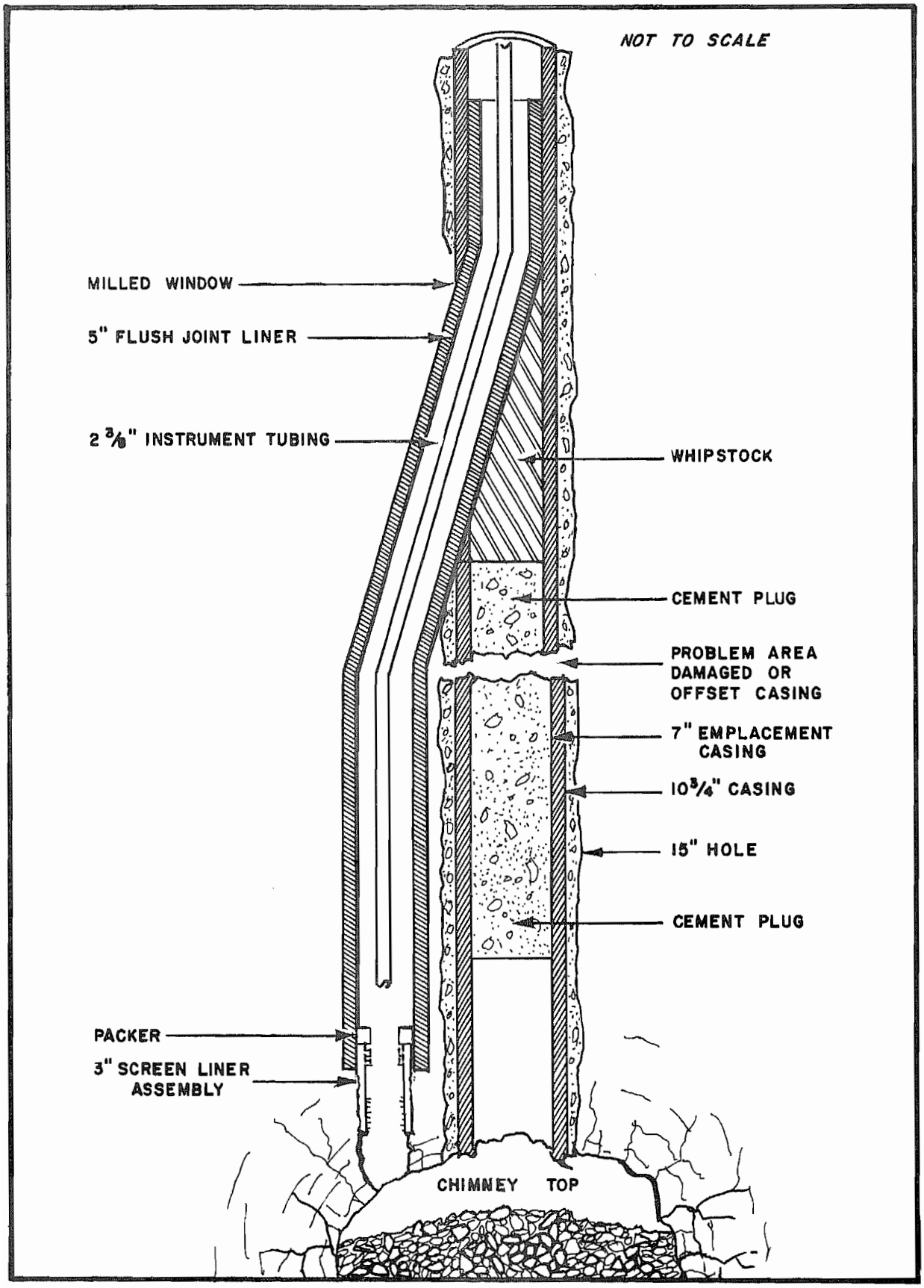


Figure IIIB-1. Schematic of Alternate Reentry Plan No. 1.

8. Snub out of hole, set packer assembly at bottom of liner, and complete as under regular reentry plan using 2-3/8-inch tubing for instrument string.

C. ALTERNATE REENTRY PLAN NUMBER 2 (Drill New Well, RB-RE-01)

In the event that reentry through the original emplacement hole is not possible, the RB-E-01 well will be plugged and abandoned in a conventional manner. Figure IIIC-1 is a schematic drawing showing the alternate reentry well plans. The following procedure will be followed to reenter the chimney:

1. Build cellar 100 feet to 150 feet from RB-E-01 and set 16-inch conductor pipe to approximately 20 feet. Cement to surface.

2. Move rig over new cellar.

3. Drill 15-inch hole to 400 feet, and run and cement 10-3/4-inch casing back to surface. Wait for cement to set 12 hours. Land casing head at a depth in cellar to allow room for BOP stack in substructure. Install and test drilling BOP's with rotating head.

4. Drill 9-5/8-inch hole to approximately 5,200 feet.

5. Log hole, and obtain caliper log on hole.

6. Run and cement 7-5/8-inch casing back to surface. Cement in two stages and land casing.

7. Clean out to shoe joint.

8. Run directional survey.

9. Install and test stripping BOP stack.

10. Perform steps 4b through 4h in original reentry drilling procedure (paragraph A. 4).

11. Run diamond bit on 5-inch Dyna Drill, etc., as in step 4j of original reentry drilling procedure.

12. Drill shoe joint and ahead until communication with chimney is established. Perform steps 4n and 4o of original reentry drilling and completion procedure.

13. Snub drill string out of hole if necessary.

14. Maintain overbalance condition. Make up 5-1/2-inch liner with wire screen and wireline removable plug above screen. Run or snub in hole maintaining mud column and land top of liner at 5,100 feet using packoff liner hanger.

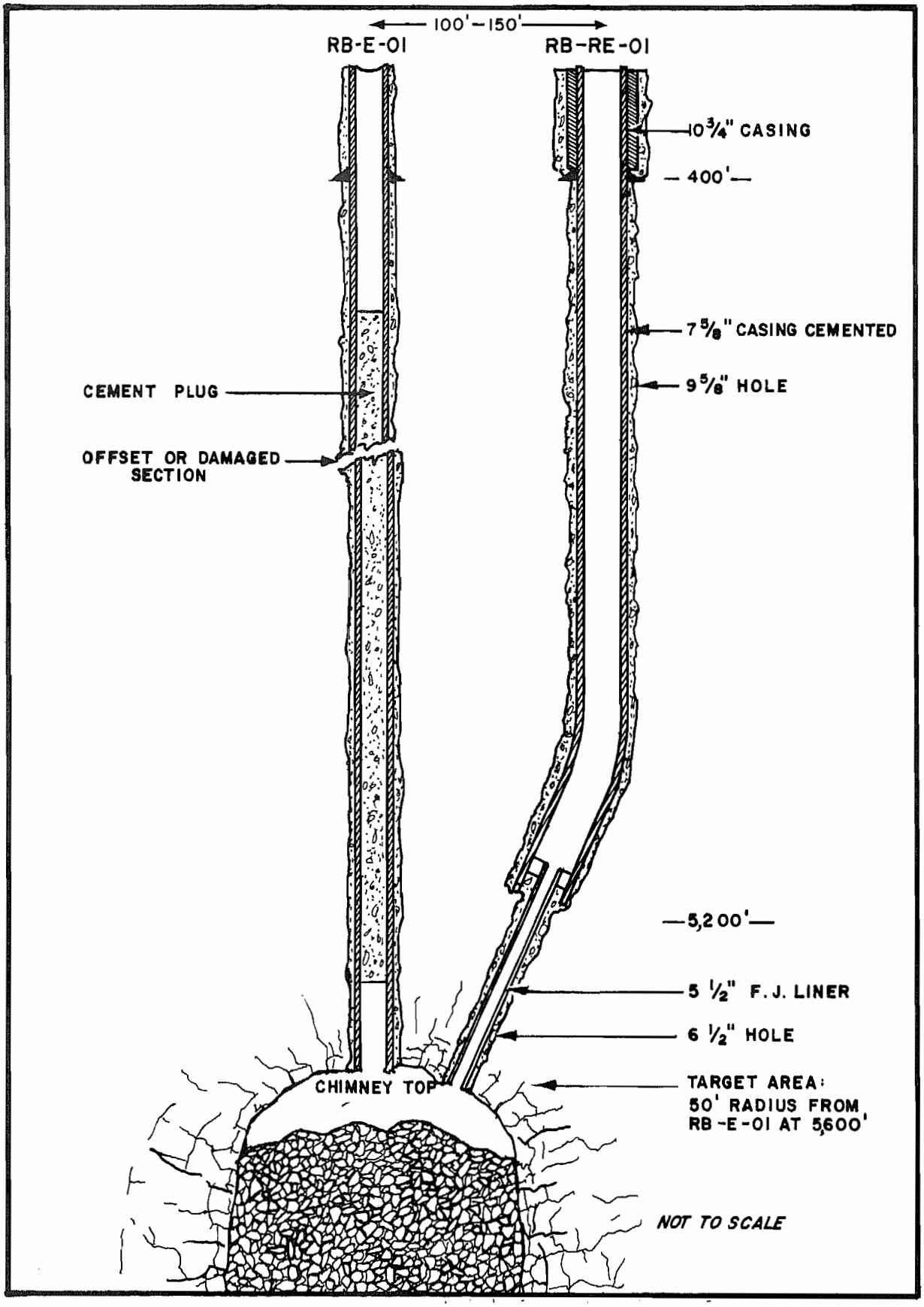


Figure IIIC-1. Schematic drawing of Alternate Reentry Plan No. 2.

15. Pull running string out of hole.

16. Run and land 2-3/8-inch tubing with wireline plug in bottom. Remove BOP stack. Flange up and pressure test wellhead to 3000 psi. Follow completion procedure in original drilling plan.

D. SCHEDULE

Figure IIID-1 shows the schedule of the major items taking place during the Reentry Drilling Program.

E. SUPPORT REQUIREMENTS

Tool-Hand Trailer, 8 x 40 feet

CER Trailer, 10 x 40 feet

Office Trailer, 8 x 20 feet

Telephone (Rig Floor and CER Trailers)

Vehicles (2 CER) W/Radiotelephones

Water, Propane for Trailers

Power (120 vAC, single phase, 40 amp) for each trailer

POL Supplies

Radio - Industrial Communications, Vernal, Utah

Contract Labor

Electrician

Welder

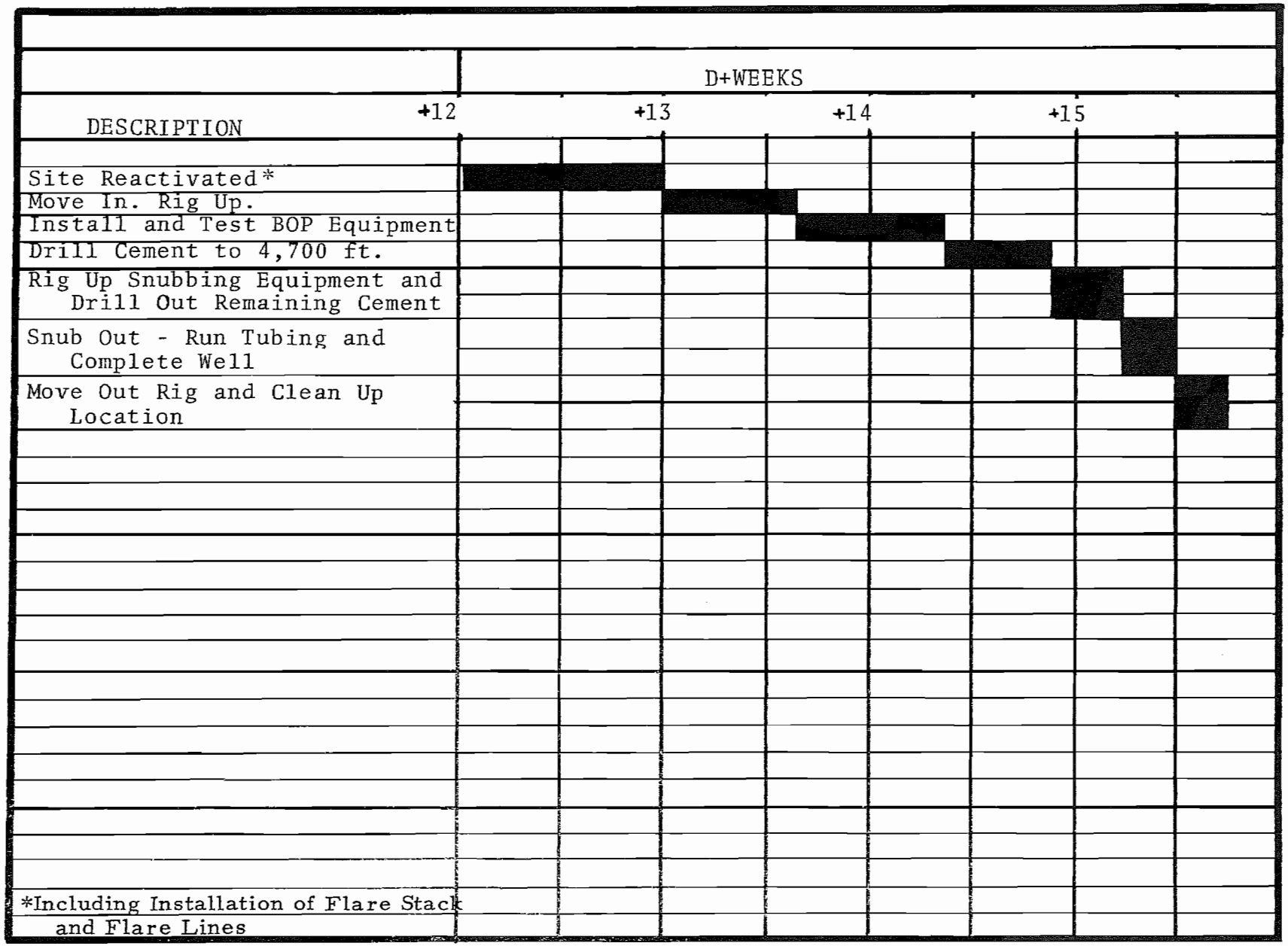


Figure IIID-1. Schedule of reentry drilling.

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. (Refer to paragraph VA-1h for the constraints on the release of radioactivity.)

Gas samples will be taken by CER during the flow testing and analysed 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.

The testing results will be continuously compared with the initial predictions to ascertain whether the program should be modified on the basis of the new data.

B. SITE LAYOUT

Figure IVB-1 shows 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 well site (Figure IVB-2). The instrument supply gas, purge gas, and pilot light gas will be supplied from the Fawn Creek Government Number 1 Well located 1,340 feet SSW of the EW. Fawn Creek Government Number 1 Well will be dually completed as a gas well and as the produced water disposal well.

Details of the Fawn Creek Government Number 1 Well will be found in Section IVG.

C. EQUIPMENT

Figure IVC-1 is a schematic diagram showing the basic production testing facilities. The gas will be produced up the 7-inch casing and out the wing valve to the high-pressure separator. Approximately two-thirds of the liquids will be removed at the high-pressure separator and further separated into water and hydrocarbon liquids (condensate) in the low-pressure separator. The volumes of the liquids will be measured and stored for later disposal. After passing through the separator the volume of the gas will be measured through a flow prover and then continue to the flare stack where it will be burned. If freezing weather conditions are anticipated during production testing, equipment design will include features to prevent water freezing in lines and tanks.

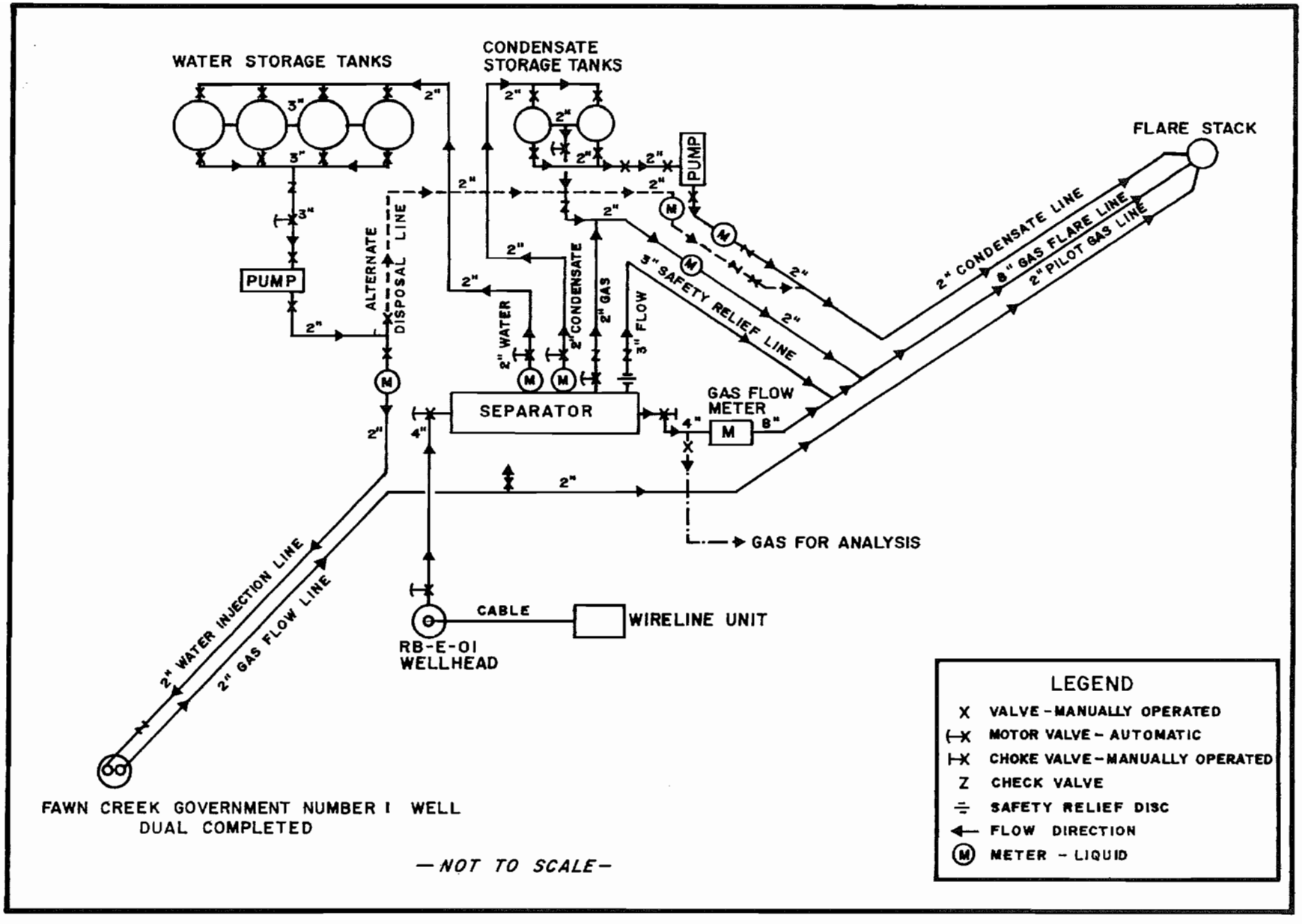


Figure IVB-1. Schematic flow diagram for RB-E-01 production test.

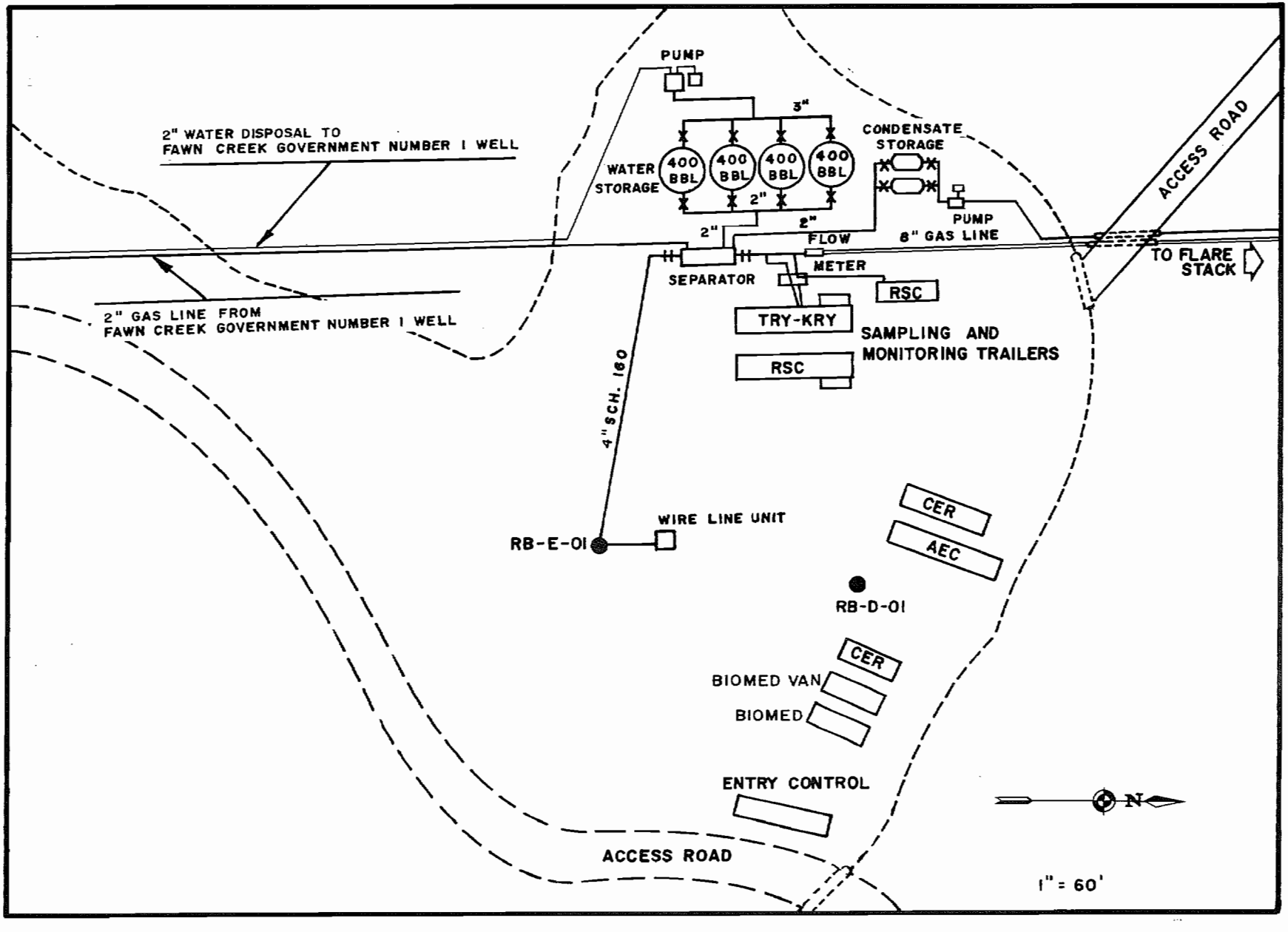


Figure IVB-2. Well site layout - postdetonation production testing.

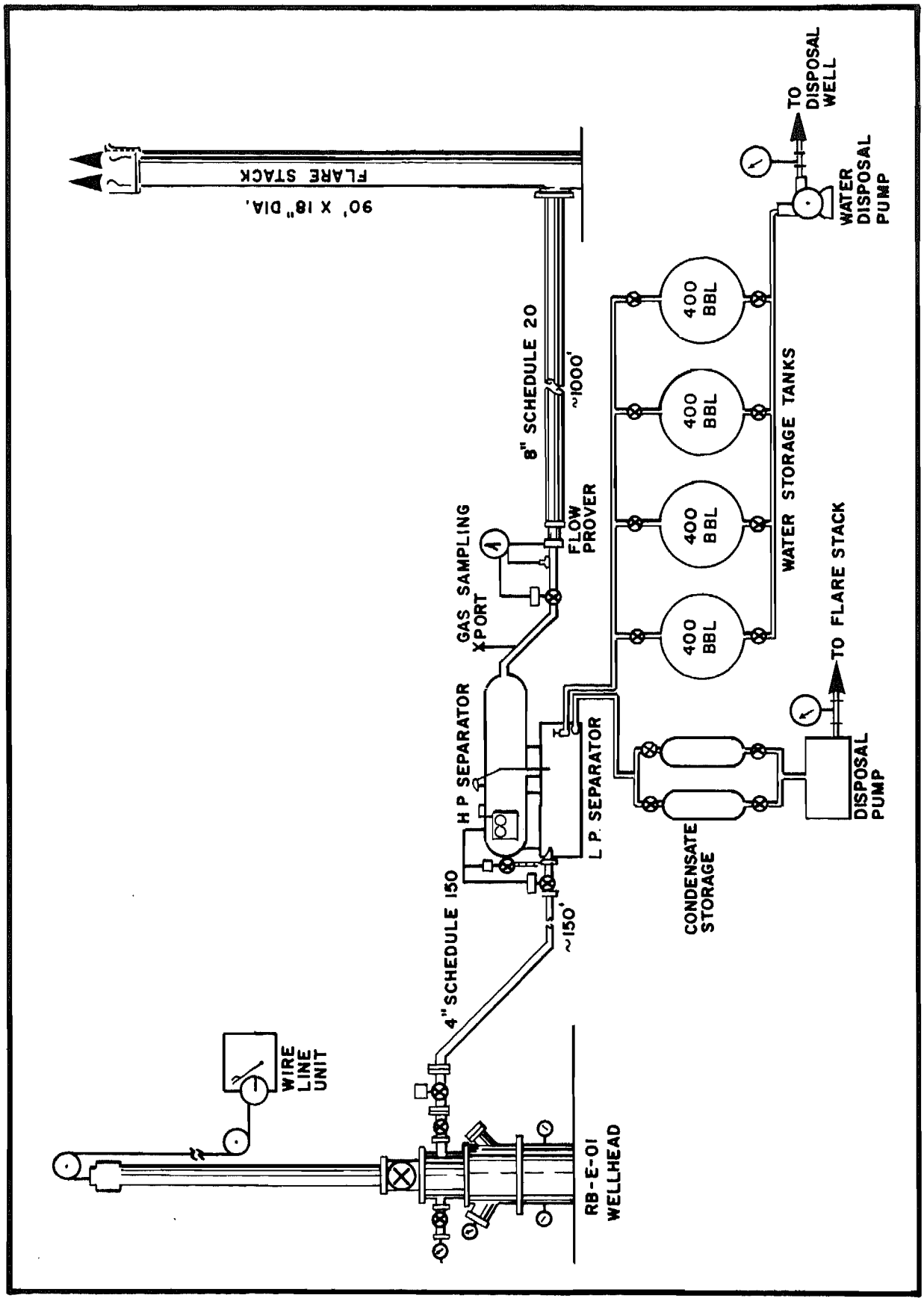


Figure IVC-1. Basic production test equipment.

1. Wellhead

Figure IVC-2 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 IVE.

2. Separator

The separator will be a combination two-phase, high-pressure separator in conjunction with a three-phase, low-pressure separator. A 500,000-BTU/hr heater will be used during startup to prevent hydrate formation. The heater will be bypassed after the flowing gas temperature is above 75°F, and the production will flow directly into the high-pressure section. The separator will be a 24-inch by 15-feet, 1,500-psi working-pressure separator designed to handle 30 MMSCFD at 1,000 psi and 300°F. Figure IVC-3 is a cutaway drawing of the separator.

The separator will be operated at a constant pressure of about 1,000 psi. The pressure to maintain a constant flow rate through the prover will be regulated using a manual choke located just downstream of the separator.

Free liquid separated from the gas stream in the high-pressure separator is transferred to the low-pressure vessel through the dump valve. Hydrocarbon condensate and water are separated out in the 125-psi working-pressure separator and metered into the respective storage vessels. Gas from the low-pressure separator and condensate storage will be metered through an orifice meter and returned to the 8-inch line downstream of the venturi flow meter.

3. Venturi Flow Meter

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 a critical-flow venturi nozzle. The flow rate is independent of downstream pressure once the flow through the prover is sonic. Constant rate can be maintained by controlling the upstream pressure. Corrections for temperature and gas gravity changes will be made in the upstream pressure to keep the rate constant.

4. Flare Stack

During the flow test the gas produced from the chimney will be measured and then burned. The stack is designed to

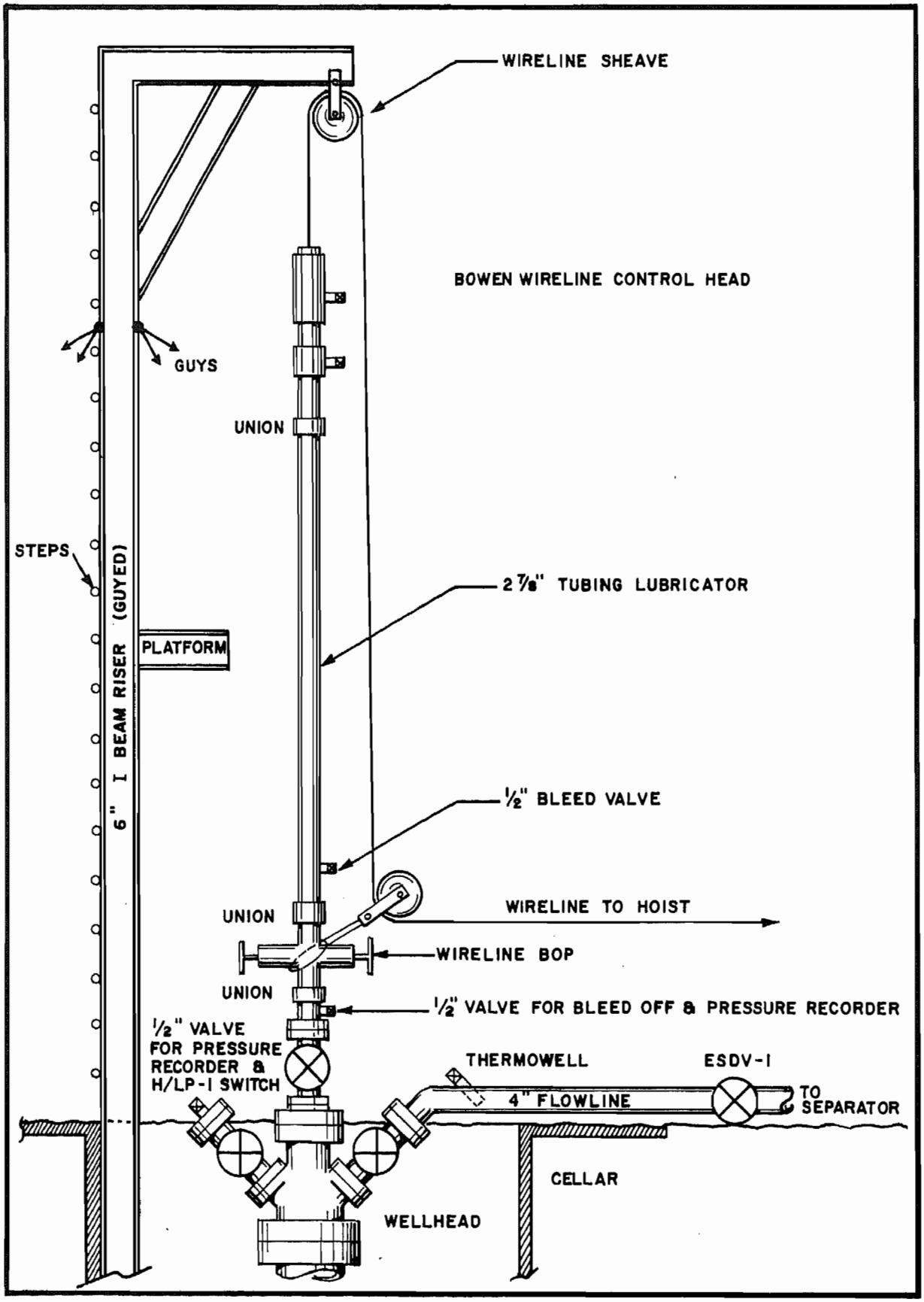


Figure IVC-2. RB-E-01 wellhead and lubricator for production testing.

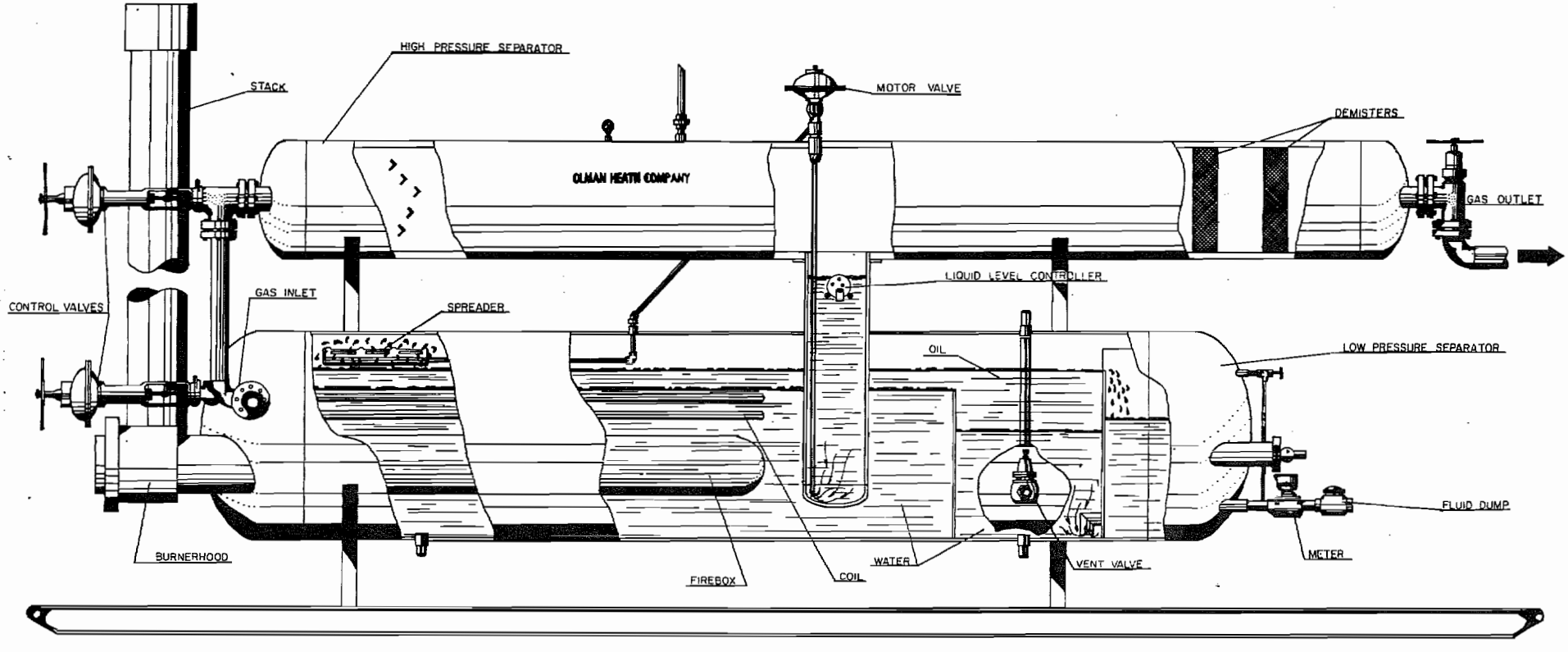


Figure IVC-3. Cutaway, combination production unit.

handle in excess of 30 MMSCFD. The hydrocarbon condensate will be injected into the flare stream and burned with the gas. The produced water will be vaporized and injected in the flare if disposal by injection into the Fawn Creek Government Number 1 Well is not possible.

5. Storage Vessels

a. Water Storage

The produced water will be stored in the four 400-barrel 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 the tanks. Details of the radioactive monitoring will be found in Section V.

6. 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 shut-in pressure buildup period the surface wellhead pressure and temperature and bottom hole pressure and temperature will be recorded. Duplicate downhole recorders will be used. 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 equipment and test design are for a 10-day flow period at a constant rate of about 30 MMSCFD. Figure IVD-1 shows the approximate expected bottom hole pressure response during the flow and early buildup portions of the test, based on reservoir parameters found in the Fawn Creek Government Number 1 Well. The calculations will be reexamined considering the conditions encountered in the RB-E-01 Well. The production test may be shortened or lengthened if the bottom hole pressure response indicates that some modification is required. However, if the response is close to the calculated pressure behavior, then the 10-day flow period should be sufficient. (Refer to paragraph VA-1h for constraints on the release of radioactivity.)

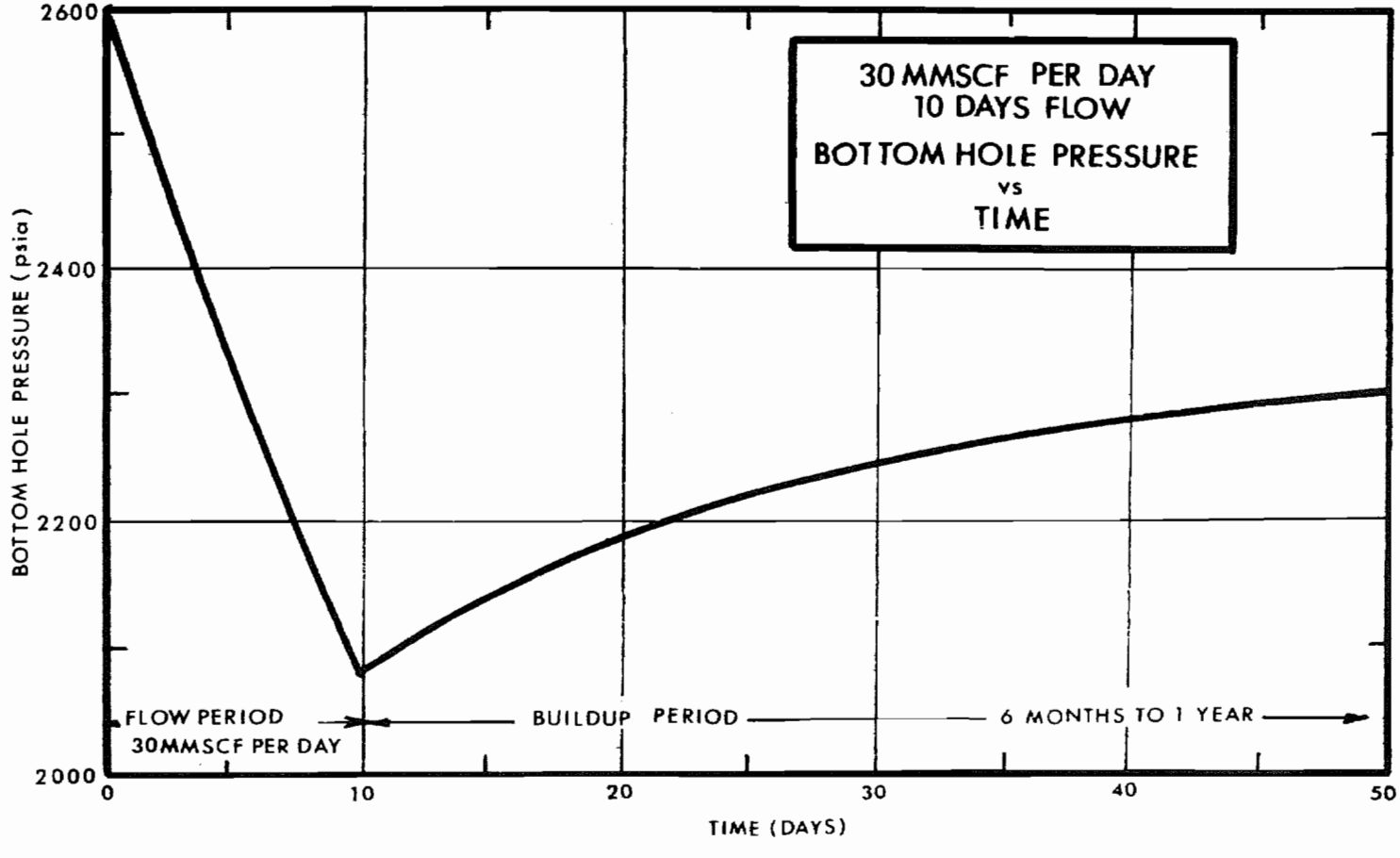


Figure IVD-1. Calculated pressure response for production testing based on Fawn Creek Government No. 1 Well reservoir parameters.

2. Data Analysis

Geophysical log, core, production test, and pressure buildup data will be used to evaluate the success of the stimulation project. The pressure drawdown and buildup data will be used to determine the chimney and high-capacity fracture volume, the fracture extent, and the reservoir production characteristics. Because of the complexity of the chimney fracture system, analytical evaluation techniques used on ordinary gas wells no longer apply. A high-speed computer model developed by LLL to match the flow rate and pressure behavior will be used by LLL to determine the physical characteristics of the project and to predict future production. An interim report on the testing analysis will be issued at about D+8 months and a final report at D+15 months.

3. Water Production Rate

Figure IVD-2 shows the calculated free water which will be separated from the gas as a function of time. Assuming the separator is to be operated at 1,000 psi and at about 300°F, the water vapor content of the gas leaving the separator is about 10 barrels per million standard cubic feet of gas. Figure IVD-3, from the "Handbook of Natural Gas Engineering" by Katz et al., is a graph showing the water content of natural gas at various conditions.

4. Gas Sampling Schedule

Gas samples for analysis will be obtained using LLL-furnished containers upon initial reentry, the first day of production testing after the gas stream has warmed up, at about 5-day intervals, and at the completion of flow testing. Additional samples may be taken and saved for checks or spot partial analysis if needed later.

The first sample will be obtained from the drilling rig flow lines or the DWC unit while the rest will be obtained at the sample port on the test section going to the RSC and CER monitoring trailers.

Samples will be obtained for chemical and radiochemical analysis by LLL. Duplicate samples will be taken. Table IVD-1 outlines the sampling and analysis schedule. Sample analysis will be expedited to establish (within 10 days) the ratio between ^{85}Kr and ^{131m}Xe and to enhance the sensitivity for ^{222}Rn.

Samples will be provided for interested parties if the sample containers and specific sampling requirements are furnished and the samples can be taken on a noninterference basis.

Gas gravity will be measured and recorded continuously using a RANAREX gravitometer. If any significant changes in gas gravity are measured, additional samples will be obtained for chemical and radiochemical analysis.

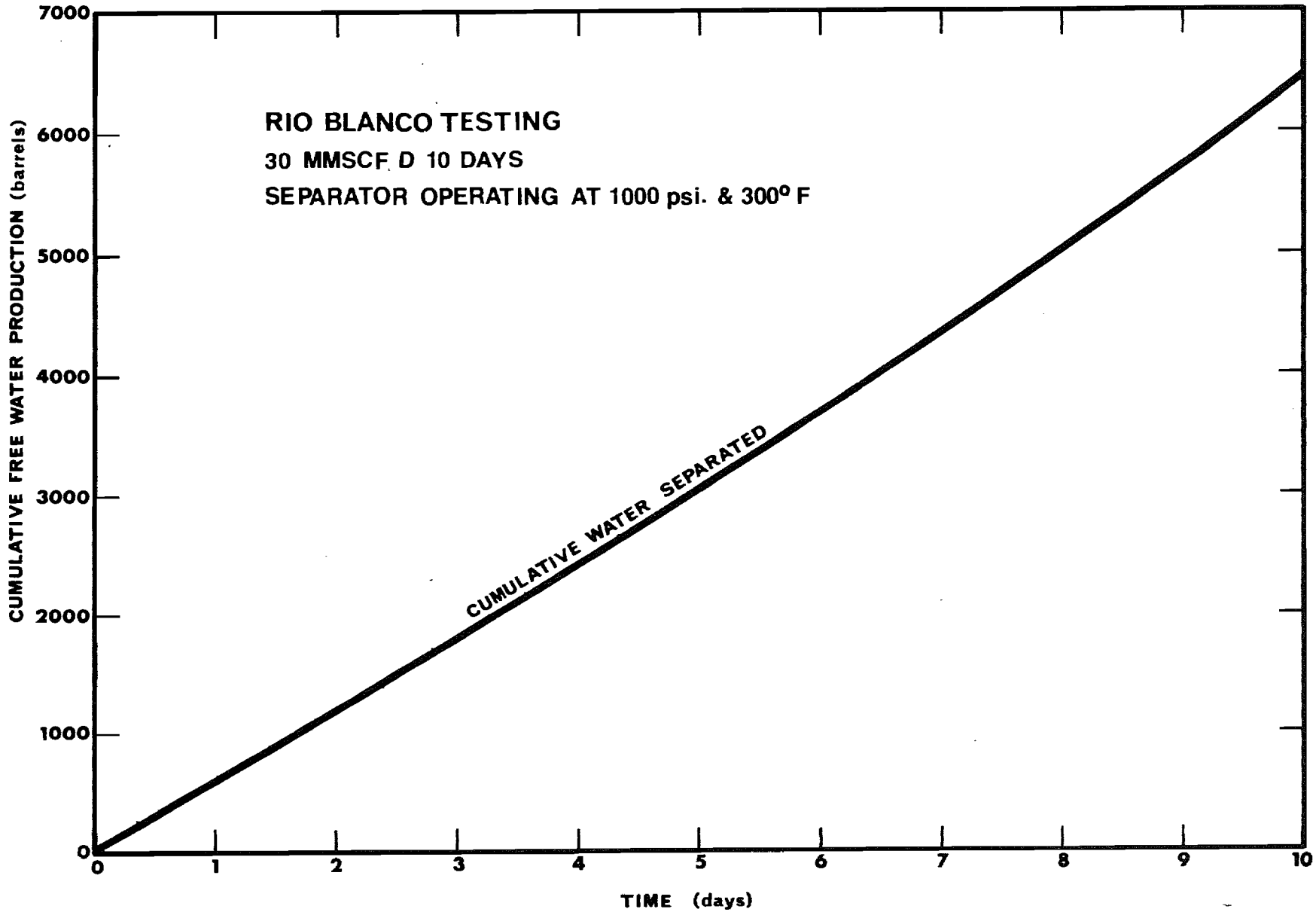


Figure IVD-2. Calculated free water production from the separator.

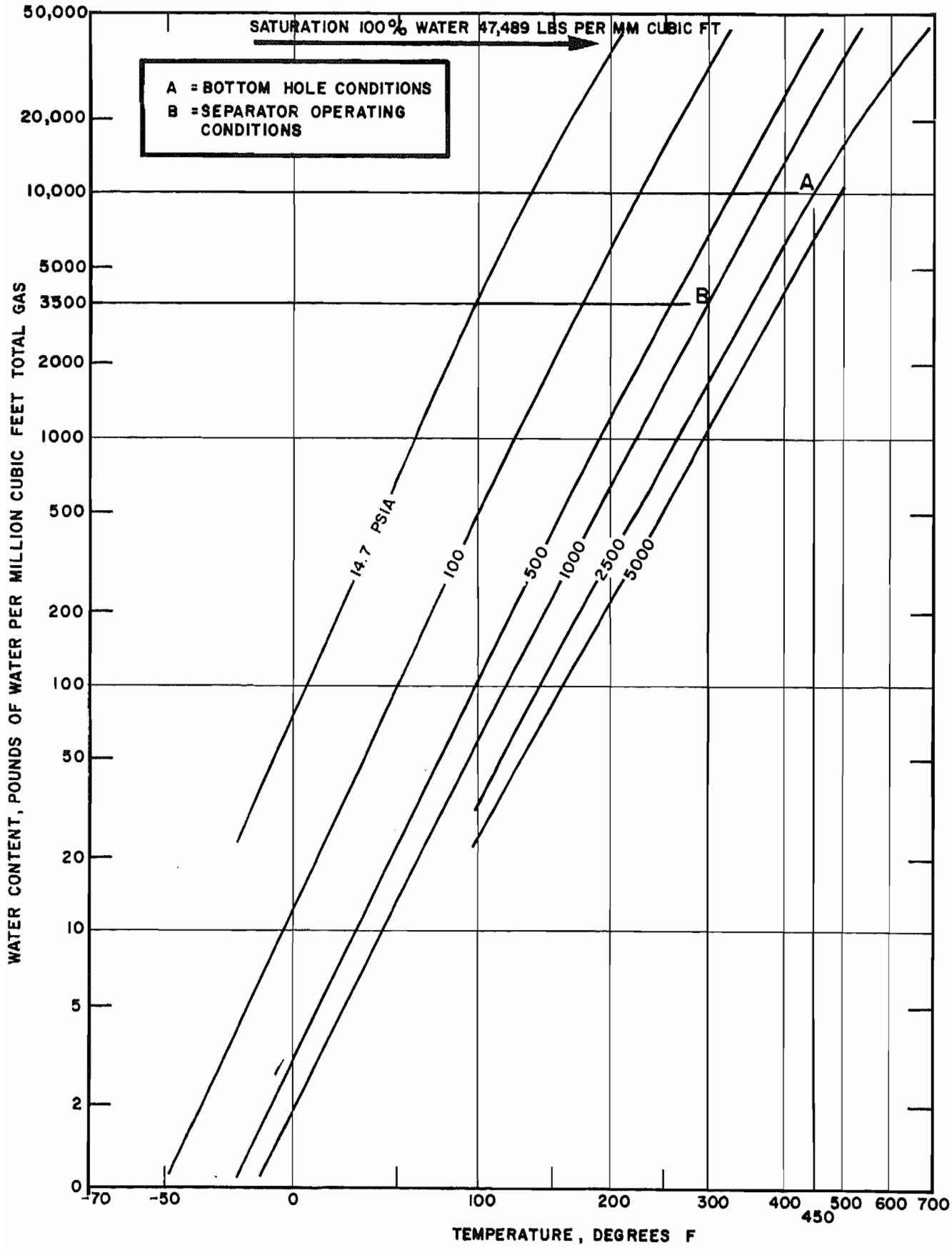


Figure IVD-3. Water content of natural gas. (after Katz, et al)

Table IVD-1. Gas sampling and analysis*

Time	Type and Number of Samples	Analysis Performed
Initial reentry	Gas, 4	Chemical** Radiochemical***
Initial prod. test	Gas, 4	Chemical** Radiochemical***
During prod. test	Liquid HC, 2	^{3}H, ^{14}C, chromatographic anal.
	H_2O, 2	^{3}H, iron, gross impurities
Every 5th day & conclusion****	Gas, 2	Chemical** Radiochemical***
Each day	Gas, 2 H_2O, 1	Partial analysis as desired from other data

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* In the event that one or more of the rate gas tracers is not detected in analysis of samples collected during production testing, subsequent sampling during the long-term pressure buildup will be considered.

** Chemical Analysis

1. N_2, CO_2, H_2S, H_2, CO, CH_4 through C_6+
2. In addition, analysis for trace amounts of the following rare gases will be run: Ne, Kr, Xe
3. Gas gravity (measured on the "as-received" sample to compare with value calculated from analysis)
4. BTU content (calculated)

***Radiochemical Analysis

1. Total tritium
2. Tritium as hydrocarbon ($CH_3\ ^{3}H$)
3. Tritium as Hydrogen ($H^{3}H$)
4. Krypton-85
5. Carbon-14
6. Argons -37 and -39
7. Radon-222
8. Xenons, particularly - 131m
9. Mercury-203

****LLL to receive 100 gal. of produced water at the conclusion of testing.

5. LLL Chimney Interconnection Program

To verify the interconnection of the chimneys, a different rare gas tracer will be emplaced in a tank just below each explosive canister, as described in Volume I. As a portion of the LLL gas analysis program, these rare gases will be looked for in the gas samples sent to LLL. The sampling schedule is given in Table IVD-1.

E. AUTOMATION AND ALARM SYSTEMS

The test equipment will be equipped with safety features wired to a remote indicating panel located in the TRY-KRY Trailer 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 IVE-1 outlines the alarm features and the functions that each system will actuate. Figure IVE-1 is a schematic of the shutdown and alarm system. If freezing weather conditions are anticipated during production testing, the system design will include an alarm against failure of heating systems.

1. Flare Stack Pilot Ignition System

The pilot lights will be ignited using an electrical arcing system. A thermocouple will activate the ignition system automatically if the pilot lights go out. If the pilot lights do not ignite, a warning light will be energized on the alarm and control panel. The circuit is shown as FF-1 on Figure IVE-1.

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 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 IVE-1).

Table IVE-1. Outline of alarm and control functions.

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

System Designation	Location
ESDV-1 - Emergency shutdown valve	On flow line at wellhead
SDV-2 - Shutdown valve	On flow line at separator
SDV-3 - Shutdown valve	On suction to water disposal pump
SDV-4 - Shutdown valve	On suction to condensate disposal pump
MC-1 - Motor controller	On water disposal pump
MC-2 - Motor controller	On condensate disposal pump

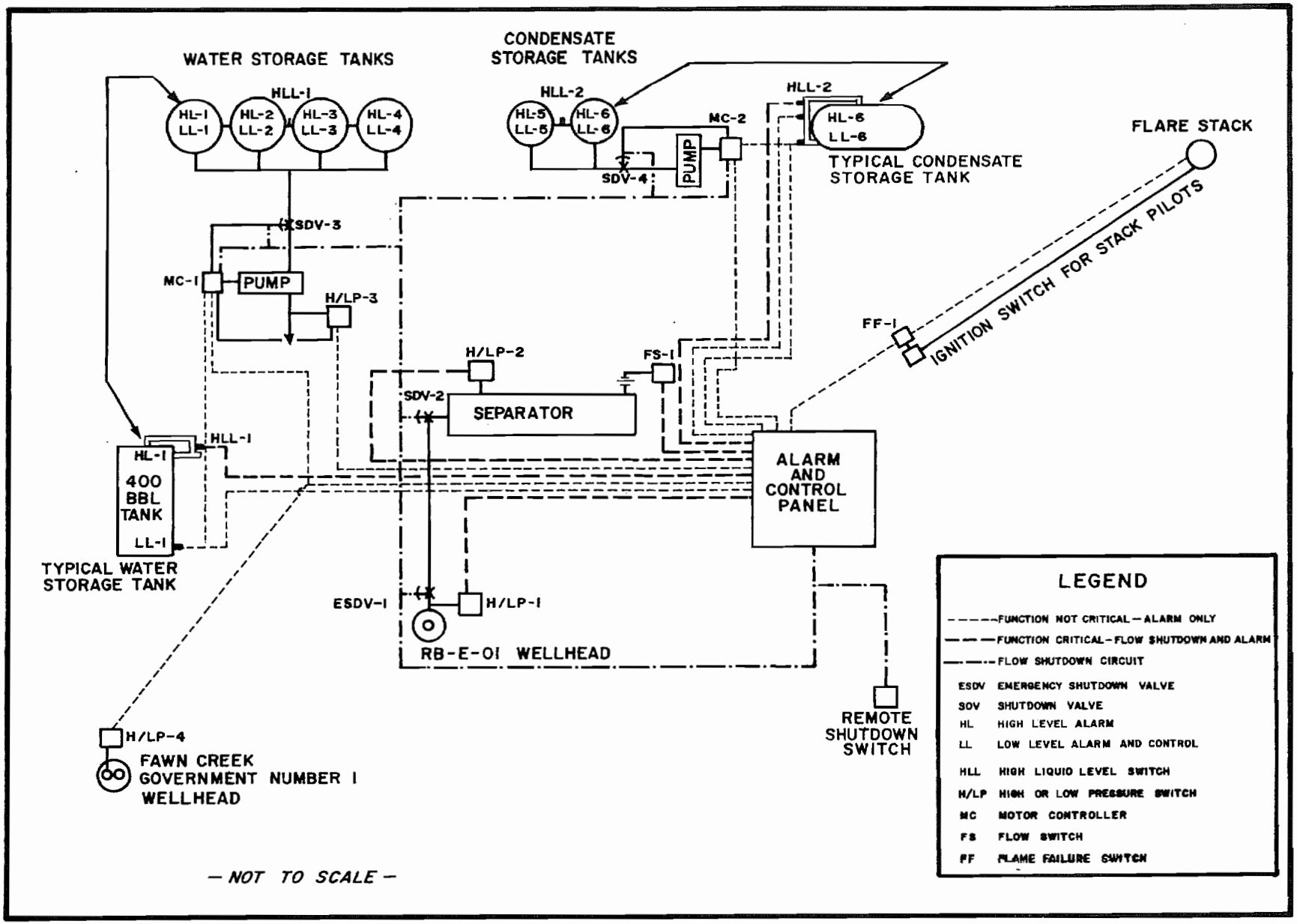

Figure IVE-1. Schematic of the shutdown and alarm system.

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 well head equipment and flow line to the separator.

5. Water Disposal Well

A high/low-pressure switch (H/LP-3) will be located at the water disposal pump and at the water injection wellhead (H/LP-4). If the pressures should exceed the preset limits, the injection pump will be shut down 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 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 TRY-KRY Trailer 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. Figure IVE-2 diagrams the Alarm and Control Panel.

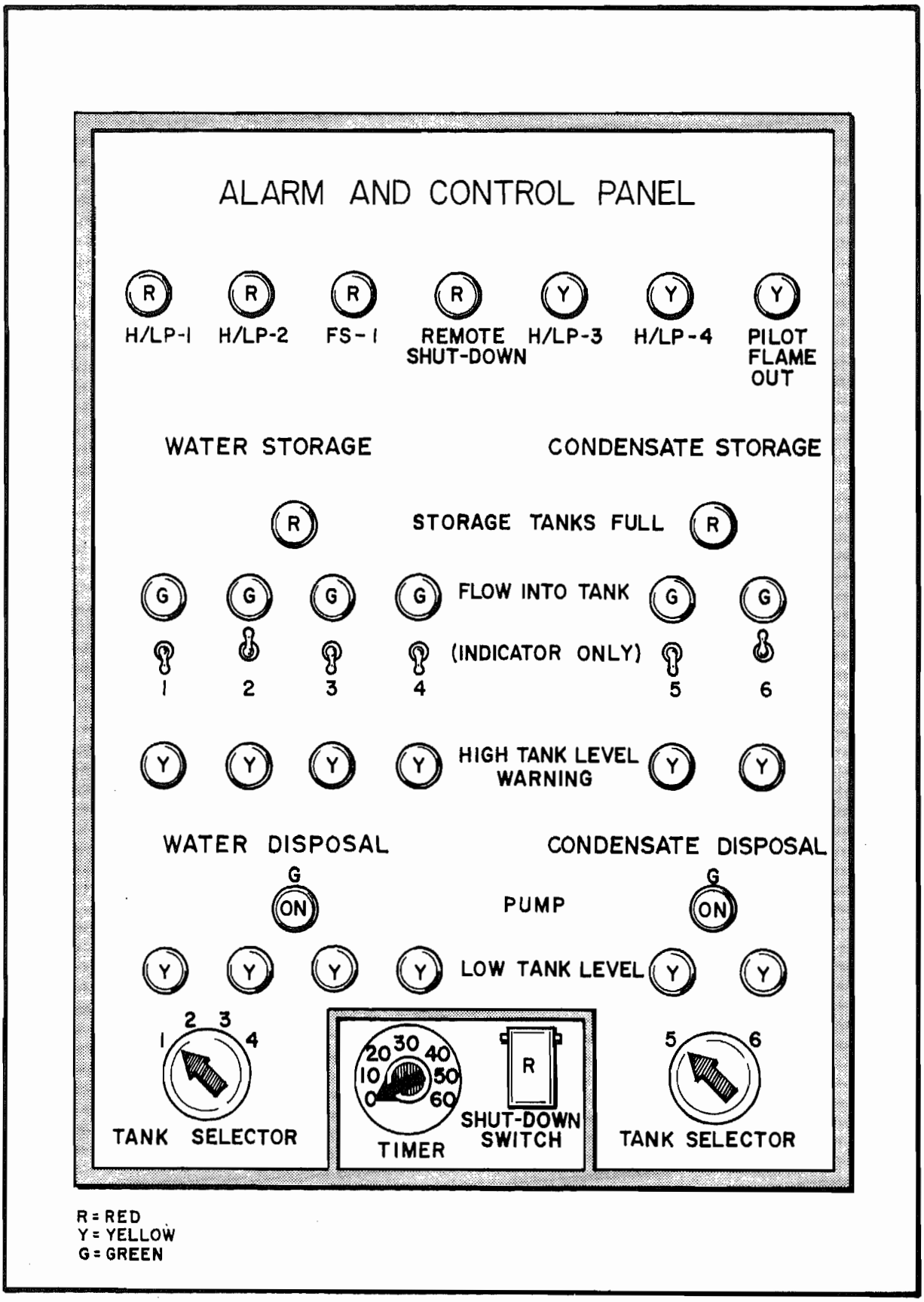

Figure IVE-2. Diagramatic layout of the Alarm and Control Panel.

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 wellhead 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. SDV-2 is a backup to the ESDV-1 valve for emergency shutdown.

Activation of the shutdown system will also shut down the water disposal system (SDV-3) and the condensate disposal system (SDV-4). A normal override will be installed on the water disposal system to allow water injection even though the RB-E-01 well is shut in.

F. OPERATIONAL PROCEDURES

1. Pressure Test

Prior to startup of the flow tests, all lines, valves, fittings, and equipment will be visually examined to ensure they are properly rated for the type of service and pressure anticipated prior to pressure testing. The pressure tests will include the following:

a. Test wing valve on wellhead to SDV-2 on separator to 3,000 psi using water.

b. Test SDV-2 to manual choke behind high-pressure separator to 1,500 psi using natural gas or nitrogen.

c. Test manual choke on separator to venturi flow meter to 1,500 psi using water. Close sample port in test section to prevent overpressuring.

d. Install blind flange in 8-inch line at base of flare stack and pressure test 8-inch line to 200 psi using natural gas from Fawn Creek Government Number 1 Well.

e. Test low-pressure separator and condensate storage vessels to 125 psi using natural gas.

f. Test water disposal line from injection pump to the disposal wellhead to 3,000 psi using water.

g. Test miscellaneous lines, valves, and fittings to the maximum anticipated working pressure using water, natural gas, or nitrogen.

2. Startup

a. Check all alarm circuitry and that alarm features are working properly. Open ESDV-1 at wellhead (wing valve closed). Activate shutdown system and check for proper valve closure.

b. Ensure that all chart drives are wound, pens are inked, and that they are working properly.

c. Light heater in separator and bring up to operating temperature (approximately 150°F).

d. Run pressure and temperature instruments to landing depth in the 2-7/8-inch tubing. Check wireline control head to make sure a gas-tight seal has been obtained.

e. Purge lines from separator to storage tanks using instrument gas from the Fawn Creek Government Number 1 Well.

f. Check all valves for proper flow condition as follows:

(1) Line from LP separator to condensate tank inlet is open. Inlet valve on second tank is closed. Outlet valves are both closed.

(2) Line from LP separator to water storage tank is open. All other valves on the water storage tanks are closed.

(3) Valves on separator are set for flow-through heater. Pressure setting on Fisher controller is set at 100 psi. Manual choke on exit of separator is set for 1 MMSCFD.

g. Purge all air from wellhead to flare stack using gas from Fawn Creek Government Number 1 Well. Purge volume required will be at least 1 MSCF.

h. Light pilot lights on flare stack. Check that the thermocouple circuit is working and indicates ignition (visual indication may be difficult during daylight hours). Ensure that purge gas is turned off.

i. Set timer on alarm and control panel for 30 minutes. (Safety shutdown features are locked out.)

j. Open ESDV-1.

k. Set pressure setting on separator at zero (inlet valves closed) and record meter readings.

l. Open wing valve (well pressure now to automatic choke on separator).

m. Start gas flow through heater and into separator. Bring separator operating pressure up to 1,000 psi initially by using choke valve manual controls. After operating pressure is reached by manual control, gradually convert to automatic pressure control by using Fisher pressure controller under limited instrument supply conditions.

n. Bring flow rate up to about 5 MMSCFD using manual choke on separator exit. Check for flare stack ignition. Keep gas temperature above 75°F to prevent hydrate formation. Once the flowing gas temperature at the wellhead is above 75°F, bring system up to 30 MMSCFD as follows:

(1) Check that timer has timed out and that the system is on automatic safety shutdown mode.

(2) Open bypass valve on separator and manually close valve on heater system. Close block valve ahead of heater.

(3) Shut off heater.

(4) Open manual choke at separator exit to desired pressure at venturi nozzle.

(5) Ensure that water and condensate meters are operating.

(6) Check all lines under pressure for leaks.

3. Normal Flow Procedures

Once the flow has been brought up to the desired rate and the safety shutdown system is operational, recheck the following:

a. Wellhead and flow nozzle recorders are operating.

b. The gas gravity recorder is operating.

c. The flow rate is constant. Corrections will be required periodically for gas gravity and temperature changes. On start-up, the temperature increase will require constant corrections to the upstream pressure at the prover.

d. Meters on the condensate and water lines to the storage tanks are operating. Record time and meter readings.

e. Wireline control head for leaks.

f. All lines for leaks.

4. Restart Procedure for Non-Scheduled Shutdown

a. Inadvertent or safety shutdown before completion of the flow test (ESDV-1 closed).

(1) Keep flare pilots lit.

(2) Close wing valve.

(3) Correct malfunction.

(4) If time period is short, continue to bypass heater on separator.

(5) Set pressure on controller at zero.

(6) Set timer at 30 minutes.

(7) Open ESDV-1.

(8) Open wing valve.

(9) Bring separator operating pressure up to previous setting.

(10) Adjust pressure on prover with manual choke as required.

(11) Record time and length of shutdown period.

b. Scheduled shutdowns; end of the flow testing.

(1) Dispose of condensate by injecting into the flare. Shut down pump.

(2) Close wing valve and bleed down pressure in entire system.

(3) Close ESDV-1.

(4) Shutdown pilot lights.

(5) Turn off instrument gas to ESDV-1, separator, and flare pilots.

(6) Purge water and condensate lines.

NOTE

Only wellhead recorder and downhole instrumentation and control head equipment will be required during buildup phase.

5. Decontamination of Test Equipment

After completion of the project and analysis of the data indicates that no further testing will be required, the equipment should be decontaminated as specified by the radiological protection guidelines outlined in Task V. The flare stack lines and production equipment will be dismantled and stored at the Equity yard for possible setup at next test site.

6. Water Disposal Procedures

Water disposal in the Fawn Creek Government Number 1 Well is initiated as follows:

a. Open valves on isolated tank to suction side of 50-horsepower triplex pump.

b. Check that high/low-pressure alarm systems at the injection well and pump are set and operating.

c. Record water meter readings.

d. Check that injection pressure recorder is wound, inked, and operating.

e. Open valves on pump discharge and at Fawn Creek Government Number 1 wellhead.

f. Check that low-level pump shutdown circuit on tank is operating.

g. Start pump. Check for leaks. System is on automatic mode and will shut down for any malfunctions.

h. Record meter readings periodically and upon injection system shutdown.

G. WATER DISPOSAL WELL, FAWN CREEK GOVERNMENT NUMBER 1 WELL

1. General

The status of Fawn Creek Government Number 1 Well at detonation time is shown in Figure IVG-1. The well will be recompleted as a dual completion. The upper Fort Union zone

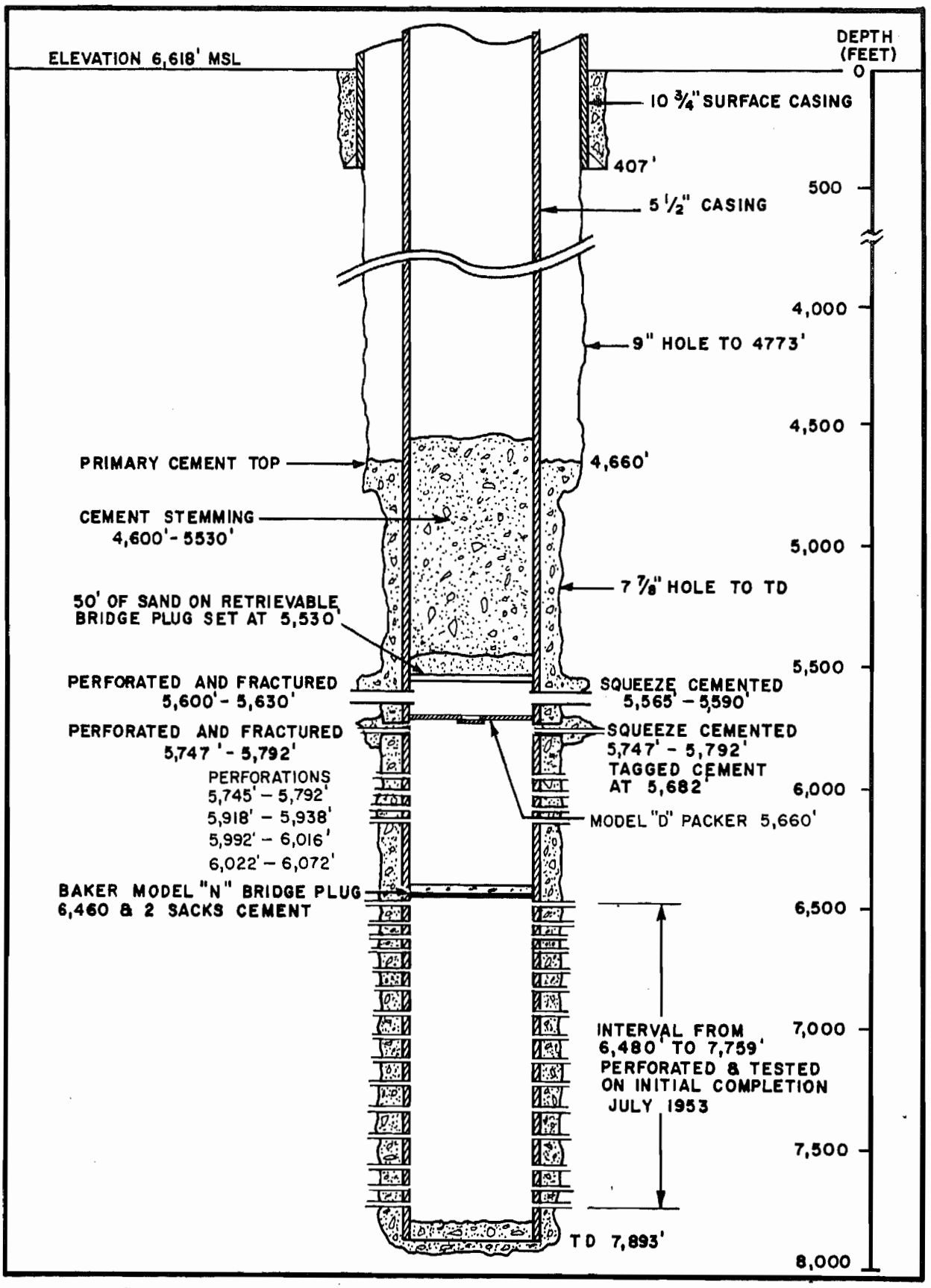

Figure IVG-1. Fawn Creek Government Number 1 Well downhole status for detonation.

will produce gas to be used as instrument supply gas, flare pilot light gas, etc., for the reentry and testing of the RB-E-01 well. The lower zone will be used for disposal, in the basal Fort Union sands, of water produced during the production testing of the RB-E-01 well. Figures IVG-2 and IVG-3 show the proposed dual completion and dual wellhead.

2. Recompletion Procedure

a. Move in and rig up workover unit.

b. Install BOP equipment.

c. Run 4-3/4-inch bit on drill tubing and clean out cement to approximately 5,530 feet. Top of cement will be at 4,600 feet.

d. At 5,530 feet the top of the sand plug should be tagged.

e. Trip out of hole, put on bridge plug retrieving tool, and run back in hole to 5,550 feet. Mix 2 percent KCl water and circulate hole with KCl water.

f. Circulate out sand above tool. Circulate in normal direction. When retrieving tool is washed over retrieving head on bridge plug, pick up to unseat valve in bridge plug and equalize pressure. There will probably be gas below the bridge plug when it is unseated. Rig up BOP equipment to allow bleedoff of the gas before starting out of the hole.

g. Circulate KCl water until all gas has been circulated out of the hole. Come out of the hole with the bridge plug.

h. Make casing scraper run to 5,640 feet. Pull and lay down drill tubing.

i. Pick up 2-1/16-inch tubing with latch-in assembly. Latch into Model D packer at 5,660 feet.

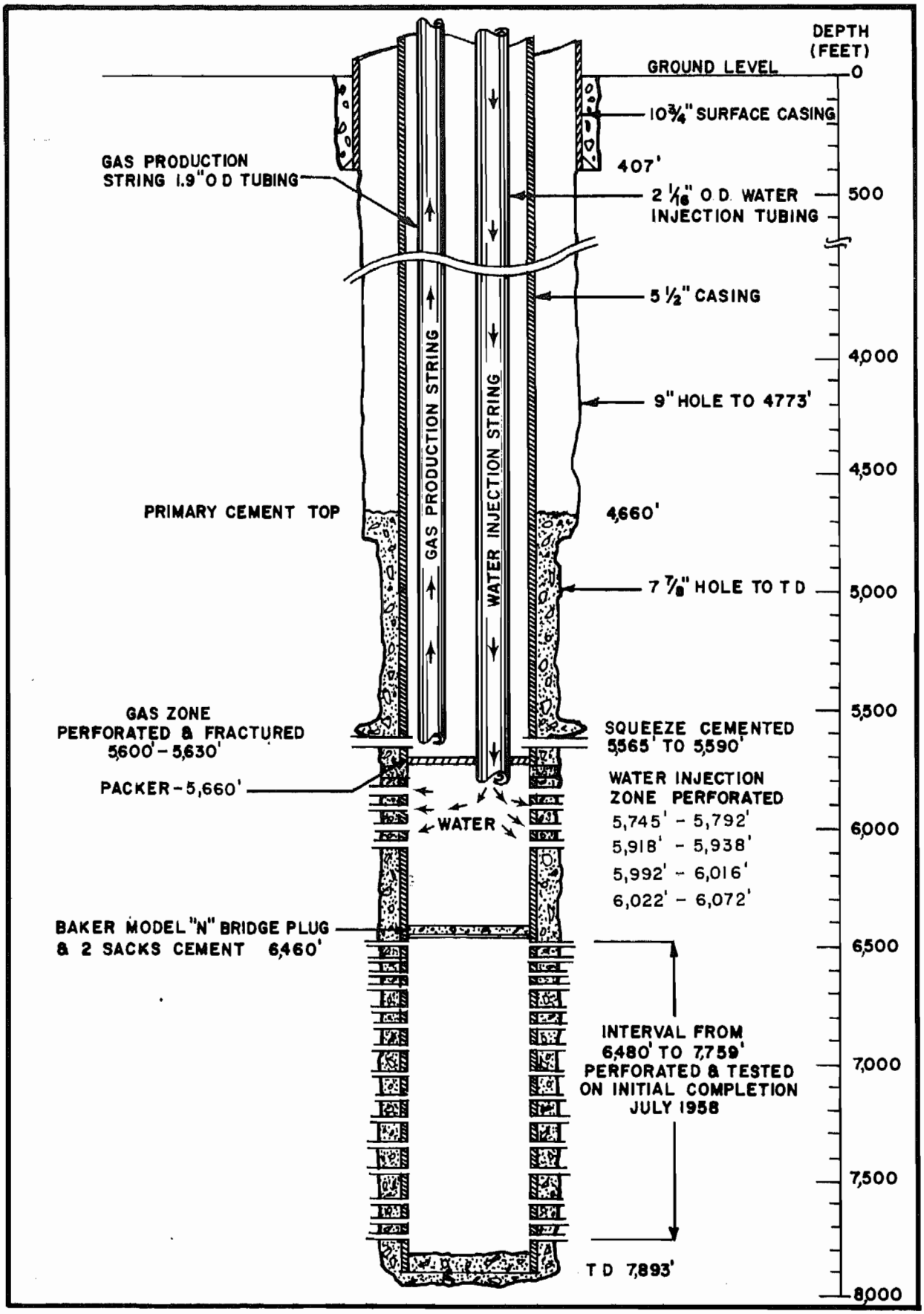

Figure IVG-2. Proposed dual completion, Fawn Creek Government Number 1 Well.

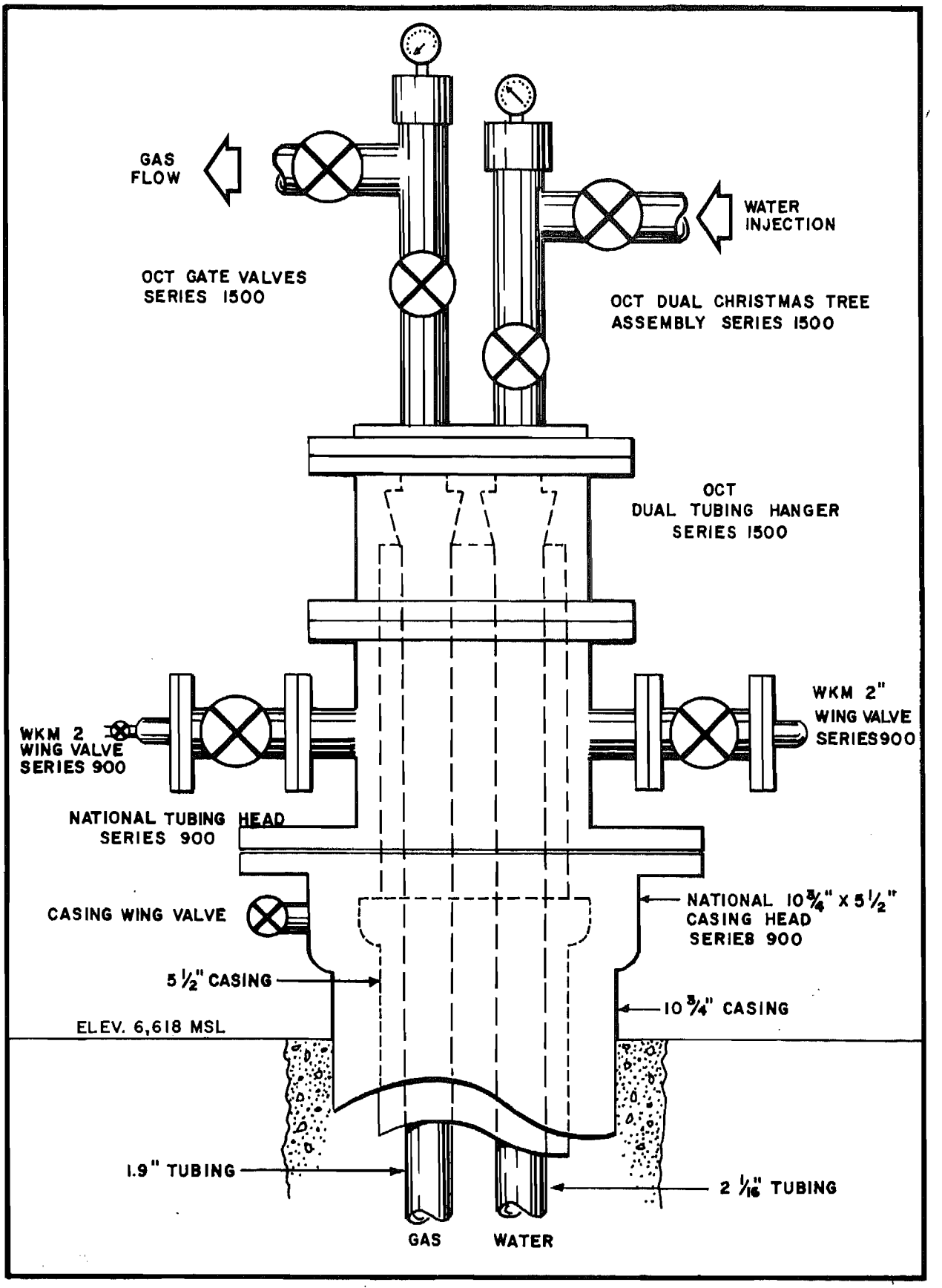

Figure IVG-3. Details of dual wellhead, Fawn Creek Government Number 1 Well.

j. Run 1-1/2-inch tubing to 5,630 feet. Land tubing in wellhead. Rig down BOP's. Install wellhead and pressure test seals to 3,000 psi.

k. Swab in gas zone through 1-1/2-inch tubing string. Flow gas to pit until zone is cleaned up.

l. Rig down and move out workover unit.

p. Rig and pressure test water injection and gas production lines.

3. Injection Facilities

The produced water will be separated, metered, and stored in one of the 400-barrel tanks. When the tank is filled to near capacity, the flow will be diverted to one of the other tanks. The full tank will then be sampled and the water injected into the water disposal well.

The volume of water that is anticipated for disposal is shown in Figure IVD-2. The amount of free water produced will change if the flow rate or length of flow testing is adjusted. The 6,000-BBL water production shown in Figure IVD-2 is based on a flow rate of 30 MMSCFD for 10 days.

The water will be metered and injected into the lower Fort Union Formation of the Fawn Creek Government Number 1 Well (Figure IVG-4) by using a triplex pump. Figure IVG-5 shows the calculated flooded area around the Fawn Creek wellbore as a function of water injected. There will be almost 120 feet of sand open to the water in the completed interval. The calculated areas are based on two cases. The first case, only 20 of the 120 feet will take the water; the other case, only 50 feet will accept the injected water. However, even under the severe case of only 20 feet taking water, the water injected during the 10-day flow test would only be displaced out to a radius of 100 feet, an area of less than 1 acre.

The pump will be equipped with both a high- and low-pressure automatic shutdown so that the lines or wellhead equipment cannot be overpressured, or, in the event of a line break, the water will not continue to be discharged through the break.

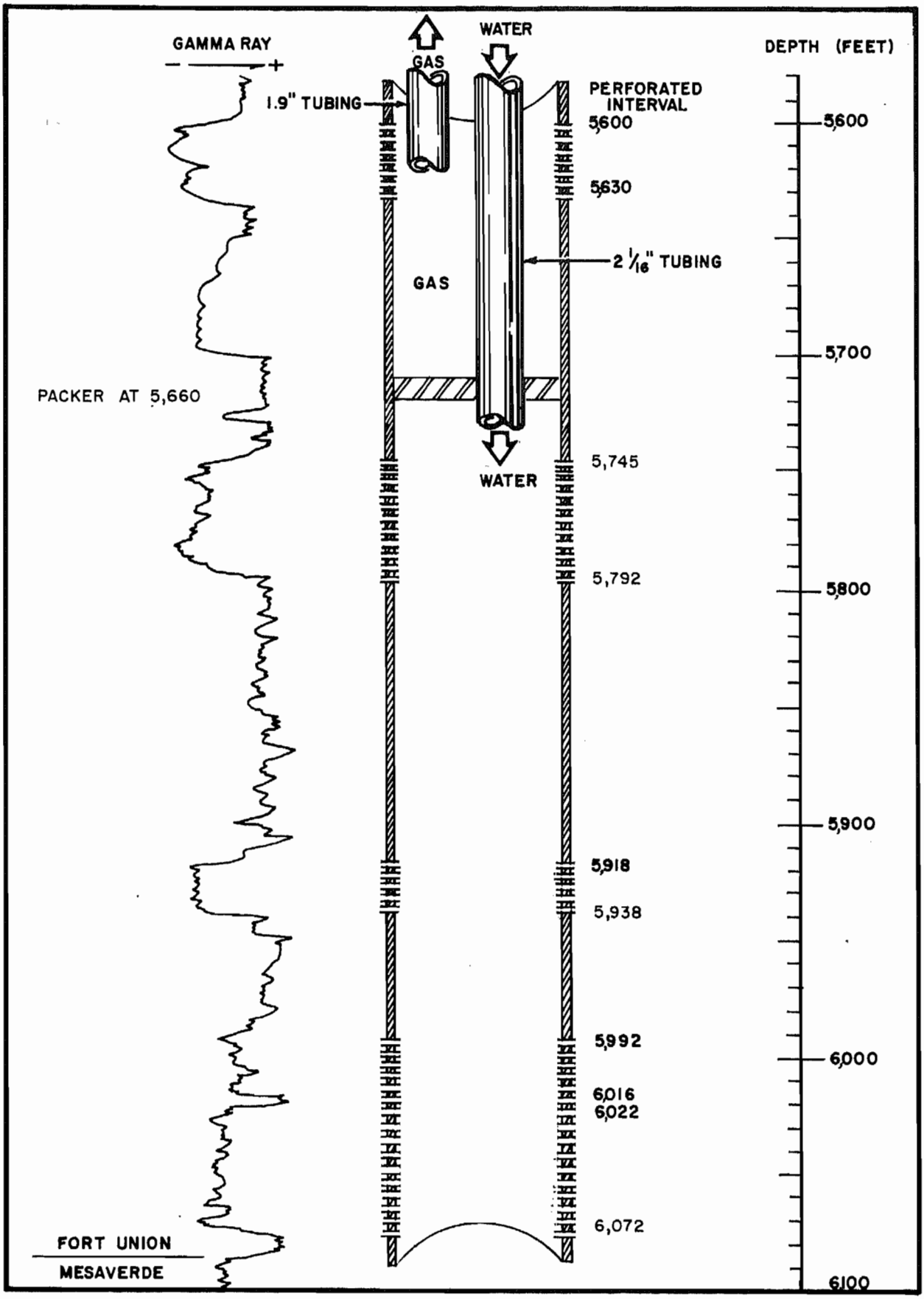

Figure IVG-4. Downhole completion detail, Fawn Creek Government Number 1 Well

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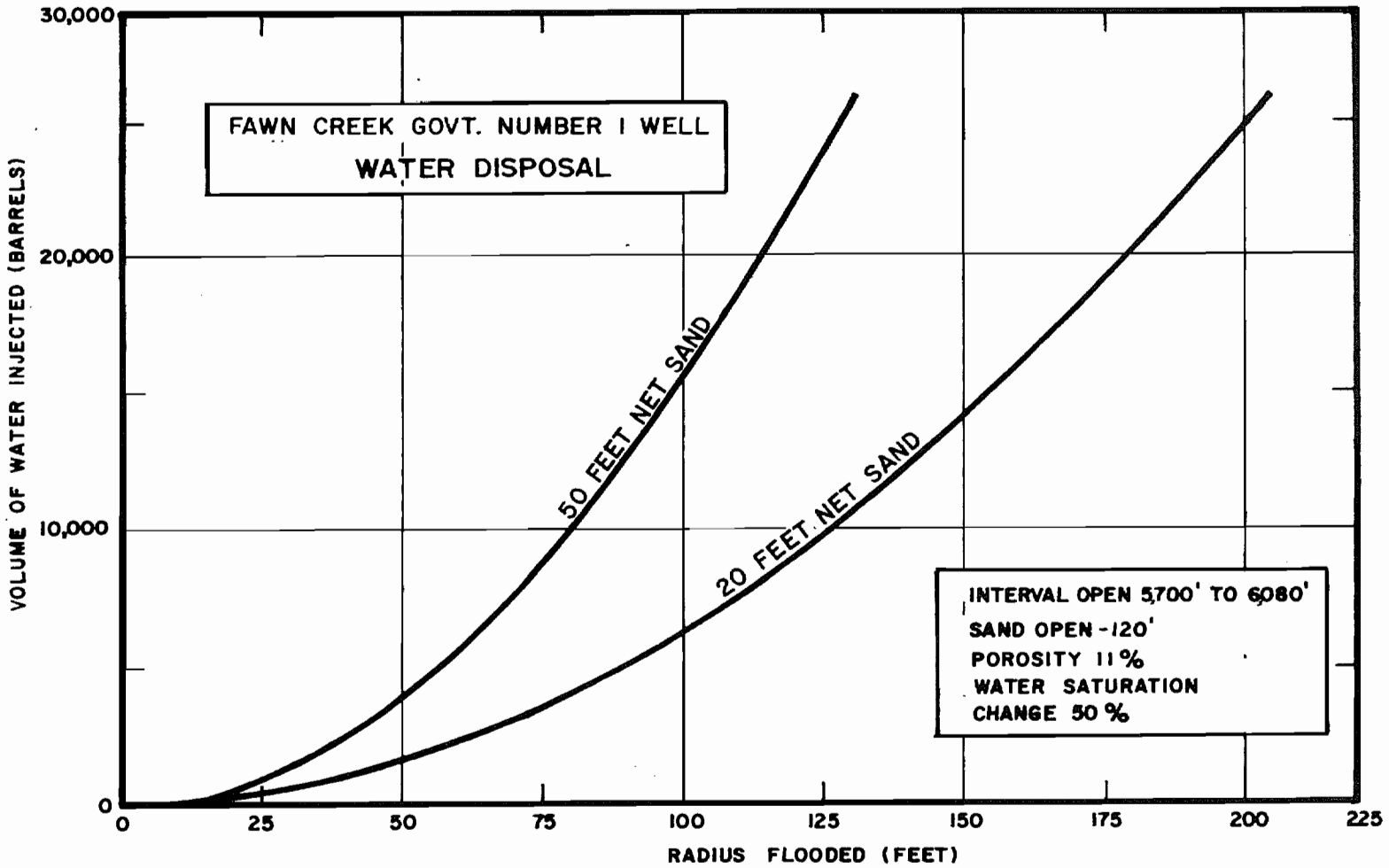

Figure IVG-5. Calculated flooded radius from injected water during production testing.

The pump will be designed to handle from 2,000 barrels of water per day (BWPD) at 1,000 psi to 1,000 BWPD at 2,500 psi.

The lines will be designed so that part of the water can be diverted to the flare stack spray nozzle if sufficient volumes of water cannot be disposed of by injection in the Fawn Creek Government Number 1 Well.

4. Alternate Disposal Plans

If use of Fawn Creek Government Number 1 Well as a water disposal well is not possible, then the alternate plan for water disposal is to inject the water back into the flare stream and re-vaporize it. A spray nozzle located at the flare stack tip will be used to inject the water into the flame. Experience during Gasbuggy and Rulison indicates that at these high flare rates, disposal of large quantities of water is possible without operational problems or hazards.

H. SCHEDULE

Figure IVH-1 shows the schedule of the major items of production test activities.

Figure IVH-2 shows the schedule of the recompletion of Fawn Creek Government Number 1 Well.

I. SUPPORT REQUIREMENTS

Vehicles (2) (with commercial radiotelephones)
CER trailer - 10 x 40 ft
Office trailer - 8 x 20 ft
Telephones in trailers (2)
Water and propane for trailers
Radio - Industrial Communications, Vernal, Utah
Welder
Contract labor
Insulation for pipes
Electrician
Gasoline tank w/hose (for cars)
Power Requirements:
Trailers: 120 vAC, single phase, 10 kw
Heat Tapes: 120 vAC, single phase, 40 kw
Injection Pump: 440 vAC, 3 phase, 50 kw

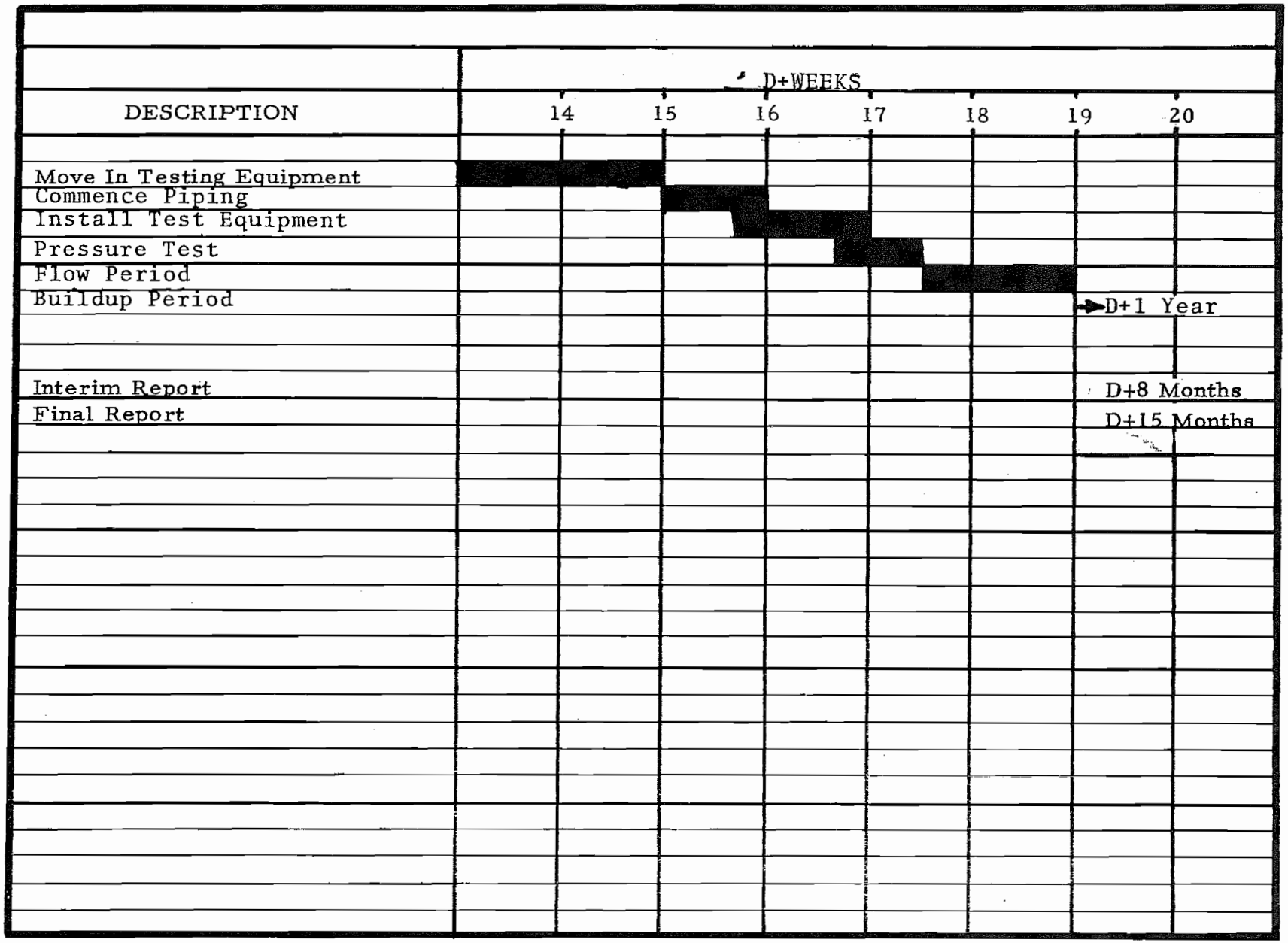

Figure IVH-1. Schedule of production test activities.

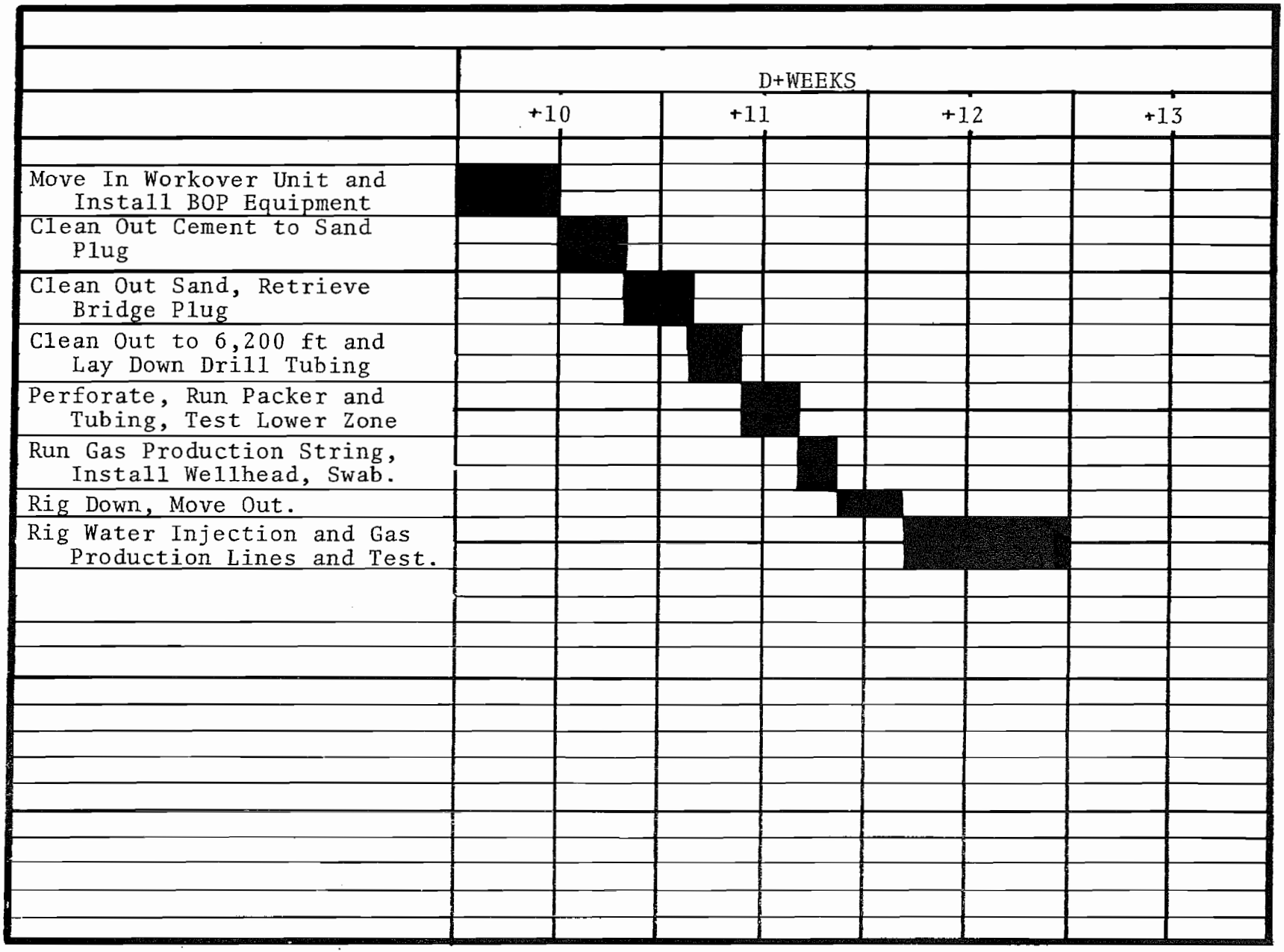

Figure IVH-2. Schedule of the recompletion of Fawn Creek Government Number 1 Well.

V. OPERATIONAL SAFETY

A. RADIOLOGICAL SUPPORT

Radiological protection and documentation of radioactive effluents will be provided from the beginning of reentry until the end of the production testing and subsequent site rollup. (Documentation of the radiological condition of the environment is discussed in Task VI.) The radiological support contractor (RSC), under contract to CER, will perform the radiological protection effort and much of the effluent documentation during reentry drilling and production flaring. CER will operate its TRY-KRY monitoring system for gaseous effluent documentation during production flaring but may monitor gas releases primarily through the DWC unit during drilling operations. The RSC will develop and provide a Radiological Procedures Manual which will include details of both sample collection techniques and analytical procedures the RSC will follow with respect to activities described below.

Released radioactive materials will be identified and their disposition quantitatively documented. It is expected that measurable quantities of radioactivity will be deposited in the immediate vicinity of both the EW and flare stack areas.

For guidance in decontamination levels for equipment and soil, please refer to letter, AEC Peaceful Nuclear Explosives/Division of Applied Technology (PNE/DAT), "Radiological Safety Guidance for Experiments Involving Nuclear Stimulation of Natural Gas Wells," dated April 17, 1972.

1. Generalized Tasks

a. Equipment

The RSC Government-owned trailers will be located on the EW pad 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) Multi-channel analyzer.

(3) Gross alpha and beta counter.

(4) TLD reader.

(5) Portable beta-gamma survey meters (e.g., Jordan Radectors).

(6) Portable explosimeters (e.g., JW #500-001 explosimeter sniffer).

(7) Emergency equipment supplies.

Additional production test monitoring equipment is described in paragraph VA-4. The equipment will be on-line downstream of the DWC unit whenever gas is released to the flare stack.

b. Access Control Dosimetry

Upon initiation of reentry drilling and until the conclusion of site decontamination and rollup, entry to the EW and flare stack areas will be controlled and a program of personnel dosimetry conducted. The RSC will issue a TLD to each project participant or visitor, will maintain records of observed exposures, and will furnish the participant's employer with the accumulated radiation exposure. TLD's will normally be exchanged and read out at intervals of 1 month. If necessary, intermediate TLD readouts will be made as directed. Bioassays of project participant urine samples will be made before reentry drilling and before and after flaring. If positive results are obtained, more frequent bioassays may be made.

c. Registration of Radioactive Sources

The RSC will register and maintain a record of each radioactive source and of radioactive calibration gases introduced into the site.

d. Radioactive Waste Disposal

The following methods of radioactive waste disposal will be employed.

(1) Preferentially, produced tritiated water will be injected into the Fawn Creek Government Number 1 Well. If this procedure is not possible, the water will be injected into the flare and vaporized.

(2) Tritiated hydrocarbons will be injected into the flare and burned.

(3) Combustible low-level tritiated solid wastes will be incinerated on site subject to appropriate air pollution controls.

(4) Soil or other media that have elevated levels of tritium contamination will be dehydrated on-site to reduce the contaminant to levels of the referenced AEC guidelines.

(5) Noncombustible solid materials that cannot be decontaminated below guidance levels will be packaged and shipped to an approved radioactivity disposal site. Department of Transportation regulations will be followed.

(6) Potentially contaminated drilling mud and water from equipment decontamination (if any) will be injected into the chimney upon completion of drilling activities. If the waste water is contaminated only with tritium, it may be disposed of as in Item (1) above.

e. Equipment and Material Decontamination

After initial detection of radioactivity in reentry drilling, all equipment and material leaving the EW area will be inspected by the RSC for radioactive contamination prior to being removed from the site. If necessary, it will be decontaminated to below the levels given in referenced AEC radiological safety guidelines. The RSC will maintain adequate records of all equipment and material leaving the site, including description, ownership, monitoring techniques, and analytical results.

f. Radiological Protection Control

If any radioactivity is detected in excess of levels specified in operating guides 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 RSC supervisor of the radiological safety program shall promptly initiate a comprehensive radioactivity survey and initiate appropriate cleanup procedures. The LLL Operations Director or AEC Project Director, as appropriate, and CER Project Director together shall determine and institute revised procedures to be followed before project work is resumed.

g. Radiological Protection Documentation

The RSC will make periodic operational reports at least daily, giving the results of all radiation measurements and sample analyses. CER will provide these data on receipt to the LLL Hazards Control representative and to the AEC Radiological Safety representative, as appropriate. Results above background will be reported immediately. CER will record volumes of gas and

liquids flared or reinjected and will correlate volumetric and specific activity data to document total releases of activity.

h. 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 significantly increase the downwind dose predictions, the production testing schedule will be modified to avoid this occurrence.

i. Radiological Safety Indoctrination

The RSC will provide a radiological safety indoctrination to all workers routinely working on site and to new workers as they arrive on site.

2. Initial Reentry Drilling*

During the first 4,700 feet of reentry drilling, unless gas pressure or radioactivity is encountered earlier, radiological protection procedures will consist of the following:

a. A sensitive beta-gamma detector will be provided in the rig floor work area to sense ^{85}Kr or other fission products. Continuous recording, on location but off the rig, will be maintained. The detector will be set to alarm at twice the normal upper limit of background readings.

b. The output of the shielded scintillation detector on the mud return line will be continuously recorded on location but off the rig. It will be set to alarm at twice the normal upper limit of background readings.

*Radiological protection program shown here presupposes reentry into the chimney through the emplacement casing. If it is necessary to drill an entirely new well (paragraph IIIC), a minimal radiological protection program would be required until drilling had progressed to a depth of about 4,000 feet, unless gas pressure or radioactivity was encountered earlier. The RSC would maintain a team of about 5 qualified individuals to provide an access control monitor and a laboratory analysis technician on a day shift basis and a responsible engineer on a 24-hour basis to maintain equipment and evaluate false alarms. Tasks described in this paragraph would be minimized to conform with the effort provided. The full schedule of activities described here would be initiated at the time noted above.

c. Radiological protection personnel will respond to and investigate with portable instruments any alarm and will take appropriate action.

d. Daily 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 ^{3}H at 1-pCi/ml sensitivity. (Gamma spectra referred to here and in subsequent paragraphs will be obtained in the field with a Nal-multi-channel system. If necessary, selected samples can be evaluated by the RSC at its laboratory with a Ge (Li-drifted) detector system.

e. Mud and waste water which drips from the drilling equipment will be collected from the cellar or drip pans in a lined pit. Prior to disposal, samples of the collected water will be assayed for ^{3}H. If the concentration of ^{3}H is equal to or greater than 10 pCi/ml, the water will be disposed of by reinjection into the chimney. Otherwise no special precautions need to be taken.

f. Daily samples of drill cuttings, when generated, will be analyzed by gamma spectra by the same method as used for mud samples.

g. A gas flare line monitoring sytem will be installed on the flare line downstream from the DWC unit. The system will be activated when the DWC unit is used. (See paragraph VA-4).

h. A rig air sampler consisting of a particulate filter and a charcoal cartridge will be continously operated. Filters will be changed daily. 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.)

i. The rig floor air will be sampled for ^{3}H by using Drierite or silica gel to absorb the air moisture. Samples will be changed daily and will be assayed for ^{3}H by liquid scintillation counting with a sensitivity of 2 pCi/ml water sample.

j. 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.

k. Temperature, barometric pressure, and humidity will be recorded to provide necessary data for quantifying site air and rig air samples.

3. Subsequent Reentry Drilling

Below a depth of 4,700 feet or at any time radioactivity or gas pressure is encountered, the radiological protection program outlined above will be continued and augmented by the following actions:

a. A qualified radiological protection monitor, equipped with a portable beta-gamma survey meter and a portable explosimeter, will be on duty on or near the drill rig at all times. When tripping out of the hole, each stand of pipe will be monitored as the joint is broken.

b. The collection and analysis schedule for mud, water, air, and drill cutting samples will be increased from once per day to once per 8-hour shift.

c. Mud and waste water will be disposed of with no restrictions imposed by radioactivity if there is no detectable fission product activity and if average tritium levels are less than 10 pCi/ml and are never in excess of 100 pCi/ml. Batches of mud and water which exceed these criteria will be disposed of by injection into the chimney.

d. Drill cuttings and residue in the mudtank will be disposed of in a routine manner if there is no detectable activity at the at the levels indicated in paragraph VA-2e.

4. Production Testing

During the production testing period, gas produced from the chimney will be continuously sampled and monitored by the production test sampling system shown schematically in Figure VA-1. This system will permit a continuous measurement of sample gas flow and radioactivity content. The on-line system will be coupled to the flare line between the separator and the flow-measurement equipment to provide a reasonably homogeneous sample of the gas stream being flared.

The production test sampling system dehydrator will provide pressure reduction and cooling for complete liquid removal prior to the gas entering the radiation monitoring section. After radiation measurements are made on the dry gas stream, the gas will be vented to the atmosphere at a rate of several CFM. The sampling port shown will allow for approximate isokinetic sampling at the design flare rate. The shielded gamma scintillation detector is recorded and the alarm set at twice the normal upper level of background readings to alert if any unexpected fission products are in the gas. If and when an alarm occurs, a gas sample will be taken and gamma scanned for identification. The heated sample line will maintain

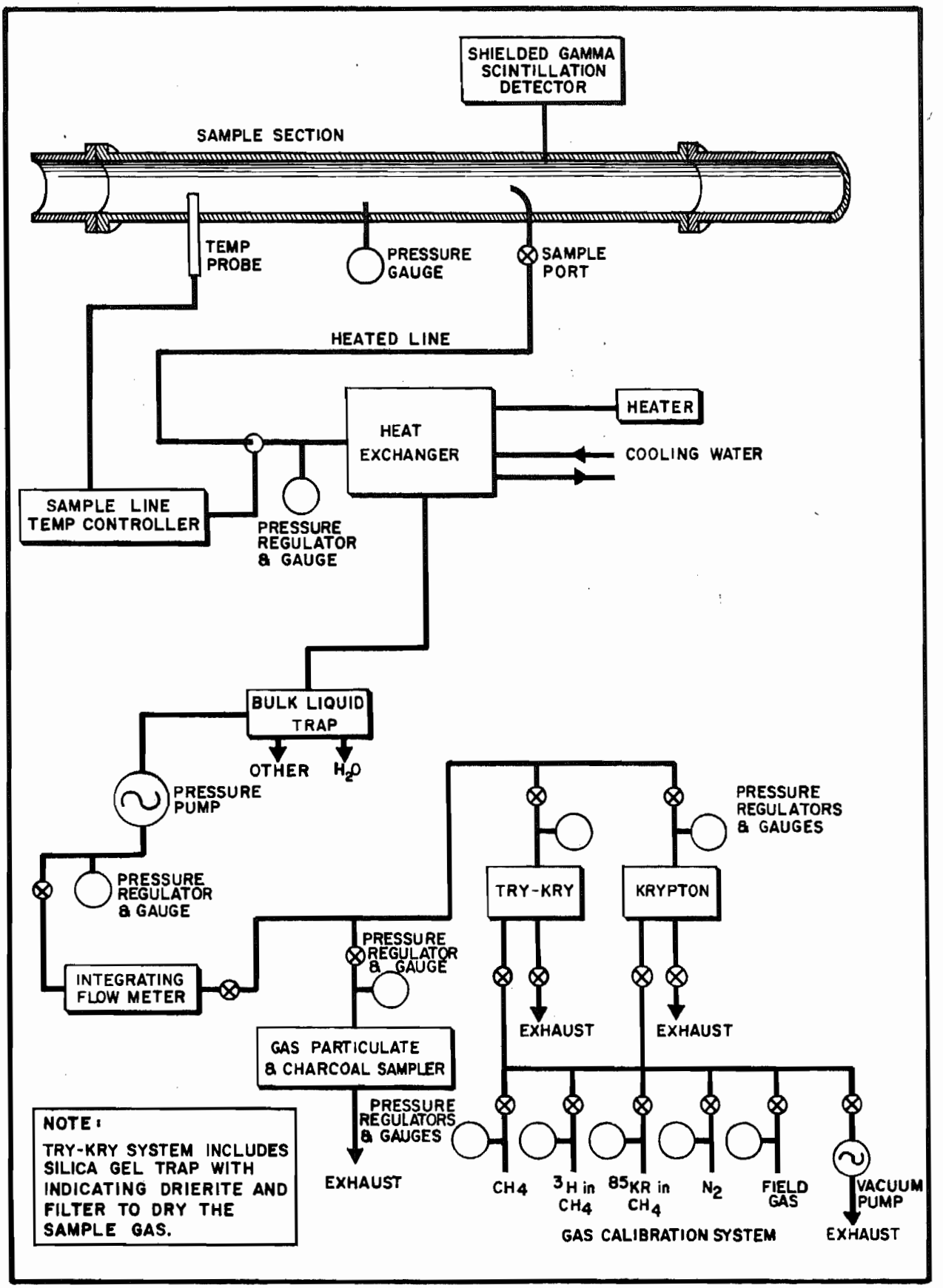

Figure VA-1. Production test sampling system.

the oil and moisture in vapor form until the gas sample has reached the heat exchanger and keep the line from freezing up during well turn-on conditions. The heat exchanger will heat the gas to approximately 45°F after expansion through the pressure regulator or cool it with available cooling water. The bulk liquids trap will drop out the bulk of the water and hydrocarbon condensates which will be transferred separately to respective storage tanks for liquids produced at separator. The pressure pump will be used to pressurize the sample manifold. The integrating flow meter will be used to quantify the analyses of the water, hydrocarbon condensate, gas particulate, and charcoal samples. The sample manifold, exhaust, and calibration system will be so connected that each detector will be independent of the operating condition of the other. The vacuum pump will be used to purge detectors and calibration lines.

The TRY-KRY system includes a proportional counter with two channels of discrimination and recording to provide differentiation between ^{3}H and ^{85}Kr activity. The system has a threshold sensitivity not greater than 1×10^{-2} pCi/ml for ^{3}H and for ^{85}Kr in methane, each in the presence of the other.

The system can discriminate against ^{37}Ar 2.6-kev X rays. The small quantities of ^{39}Ar and ^{133}Xe predicted to be present at D + 120 days should perturb the ^{85}Kr values by 1 percent or less. The ^{131m}Xe activity at 120 days is expected to be about 10 percent of the ^{85}Kr activity and would perturb the values accordingly. Adjustments can subsequently be made from laboratory analyses of gas samples as described in paragraph IVD-4.

The krypton chamber will be used as a backup to the TRY-KRY krypton measurements. This detector has a threshold sensitivity of about 1 pCi/ml for ^{85}Kr in methane.

The following measurements will be made during production testing.

a. The TRY-KRY system will be operated continuously during production with printout of recorded scaler data at preselected intervals to give counting statistics of between 1 and 0.1 percent. Associated ratemeter data will be continuously recorded. The system will be calibrated at least once daily.

b. The krypton chamber will be operated and recorded continuously. The system will be calibrated at least once daily.

c. Particulates in dry conditioned gas will be collected on paper and charcoal filters which will daily be analyzed for gross beta and gamma scanned. Filters with radioactivity in excess of 1×10^{-5} pCi/ml gross beta will be recounted 5 days later.

d. Samples will be collected from liquids drawn from the bulk liquids trap prior to disposal. The volume of the liquids withdrawn will be measured. The samples will be assayed for ^{3}H activity and by gross beta and gamma scan analyses.

e. Water from the separator which has been stored in the holding tanks will be sampled before disposal. Analysis will consist of measuring the quantity, ^{3}H content, gross beta, and gross alpha and gamma scanning. If the alpha, beta, or gamma analysis results are greater than 1.0 pCi/ml, further analyses may be required. Measurements other than for ^{3}H can be made on samples pooled over 48 hours if initial samples were at essentially background levels (except for ^{3}H).

f. Hydrocarbon condensates from the separator will be sampled before spray flaring. Analysis will consist of measuring the quantity to be flared and ^{3}H content (30-pCi/ml sensitivity) and gamma scanning. If the gamma assay is greater than 1 pCi/ml, further analyses may be required.

g. A site air sampler and air moisture sampling system will be operated continuously during production testing. Samples will be changed daily. The particulate filter will be analyzed for gross beta and gross alpha and gamma scanned. The cartridge will be gamma scanned. The air moisture samples will be assayed for ^{3}H by liquid scintillation counting with a sensitivity of 2 pCi/ml for a 5-ml water sample.

h. Temperature, humidity, and barometric pressure will be recorded to provide the data necessary to quantify the air sample data.

5. Rollup Activities

Equipment and material to be removed from the site will be inspected as prescribed in paragraph VA-1e. Radioactive waste will be disposed of according to the guidelines shown in paragraph VA-1d. The radiological condition of the site will be documented according to the procedures given in referenced AEC radiological safety guidance.

B. METEOROLOGICAL SUPPORT

CER will continue to operate five mechanical weather stations at least until the conclusion of the production testing. Four stations will be at the locations indicated in the Project Rio Blanco Environmental Impact Evaluation, Section II-I. The fifth will be at a point about 200 feet upslope from the flare stack.

The principal purpose of continued operation of these mechanical weather stations is to extend the base period of climatological wind and temperature

data collected in connection with the project to at least 3 years. It is not planned to reduce the data specifically for the current project but to make it available for use in follow-on projects. However, the records would serve to document wind and temperature conditions at the time of production testing and would be available for reference, if needed. The highly favorable dilution factors observed on Project Rulison suggest that the expense of more elaborate weather observations is not warranted. As noted previously, measurements of temperature, atmospheric pressure, and humidity will be made near the EW. No measurements are planned of the vertical distribution of temperature or wind except the recordings near the EW and the flare stack. However, estimates of wind speed and direction will be made and used by the project's radiological safety staff for predictions of plume rise and dispersion. Based on measurements of ^{85}Kr and ^{3}H, predicted downwind concentrations will be used to extimate dose rates to populated areas.

C. SCHEDULE

Figure VC-1 shows the schedule of radiological safety activities.

D. SUPPORT REQUIREMENTS

1. RSC trailers are already on site. Move TRY-KRY Trailer to EW area.

2. Power:

RSC trailers already equipped. Provide TRY-KRY Trailer with 120-vAC, 60-Hz, 30-ampere power.

3. Water:

Nonpotable, reasonably clean water supply to Entry Control and Sample Preparation trailers.

4. Water Drain:

Entry Control - normal

Sample Preparation - holding tank (200 gal. capacity) and electric pump with check valve into contaminated water line. Pump specifications: Teel 1/2-hp, high-speed, self-priming centrifugal or equivalent.

5. Procure 50 barrels.

6. Fenced storage yard for 50 barrels.

7. Four telephone lines for phone answering and call routing service.

8. Labor support for equipment decontamination and miscellaneous needs.

9. Relocate TRY-KRY Trailer to Grand Junction building at rollup.

10. Hook up propane heater in TRY-KRY Trailer, repair as necessary, and provide propane service.

11. Provide winterizing skirt around TRY-KRY Trailer.

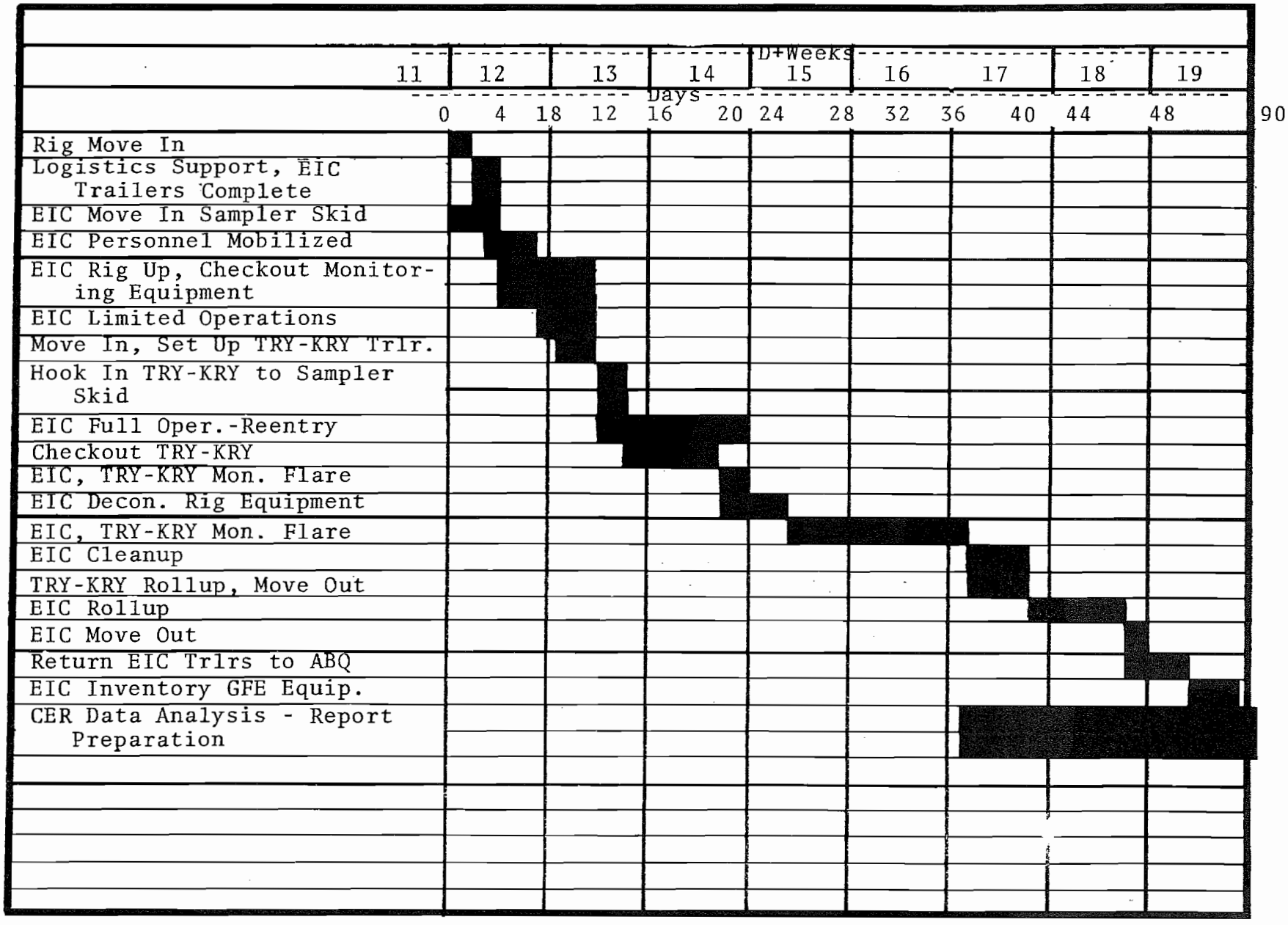

Figure VC-1. Radiological safety schedule.

VI. ENVIRONMENTAL PROTECTION PLAN AND DOCUMENTATION

A. RADIOLOGICAL

The environmental sampling program described in Volume II, performed by the RSC, will be continued until about 6 months after completion of production testing. However, it will be modified in connection with the flaring program as described below. The modified sampling program is summarized in Table VIA-1. It will be conducted in accordance with the RSC's Radiological Procedures Manual. Sampling locations and sensitivities are listed in Volume II. In the contingency of an unanticipated release of radioactivity, the modified sampling program may be augmented at the direction of the APD.

1. Air Sampling

Additional air sampling stations will be activated 1 week prior to the scheduled commencement of flaring at the three Class B locations not regularly so equipped. The sampling schedule will be continuous with weekly filter changes (both particulate and charcoal) until the conclusion of flaring and will be timed so that samples are changed on the days flaring begins and ends. Sample analyses remain unchanged.

2. Water Sampling

Additional water samples will be collected immediately before and after the flaring operation at each of the six locations listed in Class A, 5 and Class B. Intermediate samples will be taken at intervals of 3 days. Furthermore, additional water samples will be collected at the Class C and D locations weekly during and after the flaring operation for a period of at least 4 weeks, extending until at least 1 week following the conclusion of flaring. These additional samples will be assayed for tritium activity by liquid scintillation methods and for other nuclides by gamma spectrometry.

3. Air Moisture Sampling

Air moisture sampling stations will be activated 1 week prior to the scheduled commencement of flaring at two of the Class B locations. The sampling schedule will be continuous with daily collections commencing 2 days before flaring and continuing until the end of flaring. Samples from each location will be compounded to provide one background plus weekly integrated values during flaring. Samples will also be collected at each of the two stations described in Class A, 4 of any precipitation occurring during the flaring operation. Occasional samples of precipitation may also be collected at the Class B locations. Samples will be assayed for tritium by liquid scintillation.

Table VIA-1. Environmental sample analysis and annual frequency.

Type of Sample and Analysis	Class of Location[1]																	
	Class A (near EW)					Class B (nearby ranches)				Class C (population centers)					Class D (lakes and streams)					
	1	2	3	4	5	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6
Air: Gross Beta	12(3)					(3)	(3)	(3)	12(3)	12	12	12	12	12						
Gamma Scan[2]	4(3)					(3)	(3)	(3)	4(3)	4	4	4	4	4						
Gross Alpha[4]																				
Water: Gross Beta					4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Gamma Scan					4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
$^{89,90}Sr$[5]																				
Gross Alpha					4	4	4	4	4	4	4	4	4	4						
Actual ^{3}H						4	4	4	4											
^{3}H - liquid. scint.					(6)	(6)	(6)	(6)	(6)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)
Air Moisture: Actual ^{3}H[8]									4											
^{3}H - liquid scint.						(9)	(9)	(9)	(9)											
					(10)	(10)	(10)	(10)	(10)											
Soil: Gamma scan	2	2	2	2		2	2	2	2	2	2	2	2	2						
^{3}H - liquid scint.	2(11)	2(11)	2(11)	2(11)																
$^{238,239}Pu$	(12)	(12)	(12)	(12)																
U and Th	(12)	(12)	(12)	(12)																
Vegetation: Gamma Scan		2(11)	2(11)	2(11)		2(11)	2(11)	2(11)	2(11)											
$^{89,90}Sr$		2(11)	2(11)	2(11)		2(11)	2(11)	2(11)	2(11)											
^{3}H - liquid scint.		2(11)	2(11)	2(11)		(11)	(11)	(11)	(11)											
Milkcow Feed: Gamma Scan						2(11)	2(11)	2(11)	2(11)											
$^{89,90}Sr$						2(11)	2(11)	2(11)	2(11)											
^{3}H - liquid scint.						(11)	(11)	(11)	(11)											
Milk:																				
Gamma Scan						4	4	4	4											
$^{89,90}Sr$						(5)	(5)	(5)	(5)											
^{3}H - liquid scint.						(6)	(6)	(6)	(6)											
Animal Tissue: Gamma Scan		2(11)	2(11)			2(11)	2(11)	2(11)	2(11)											
$^{89,90}Sr$						2(11)	2(11)	2(11)	2(11)											
^{3}H - liquid scint.		2(11)	2(11)			(11)	(11)	(11)	(11)											
Fish Gamma Scan					2(11)										2	2	2	2	2	2
$^{89,90}Sr$																				
^{3}H-liquid scint.					2(11)										2	2	2	2	2	2
External Bkgrd. -TLD[13]	4	4	4	4		4	4	4	4	4	4	4	4	4						
Bioassays: ^{3}H - liq. scint.						(14)	(14)	(14)	(14)											

Table VIA-1. Environmental sample analysis and annual frequency (Cont.)

(1) Locations listed in Volume II.
(2) Quarterly composite except during flaring.
(3) Weekly during flaring.
(4) Save all filters until conclusion of program for possible alpha analyses.
(5) Only if gamma scan indicates presence of significant quantity of ^{137}Cs.
(6) Before and after flaring. At 3-day intervals during flaring. All locations indicated plus dairy near Meeker.
(7) Weekly for at least 4 weeks, extended until 1 week after end of flaring.
(8) Not used.
(9) Daily before (2 days) and during flaring. Integrated before flaring and weekly during.
(10) Opportune precipitation samples.
(11) Also before and after flaring.
(12) After flaring only.
(13) Exchanged quarterly.
(14) Before and after flaring. Additionally during flaring if suspected exposure.

4. Soil Sampling

Additional soil samples will be collected before reentry drilling and after the flaring operation at each of the seven stations listed in Class A, 1-4 inclusive. The soil moisture in each sample will be assayed for tritium activity by liquid scintillation.

5. Vegetation and Milkcow Feed Sampling

Additional samples will be collected before and after the flaring operation. Samples from Class A locations will be representative deer browse species; samples from Class B locations will be cattle fodder and milkcow feed, if appropriate; all samples will be identified by species. Sample analyses will remain unchanged except that at Class A and B locations, assay for ^{3}H in the sample moisture by liquid scintillation will be included.

6. Milk Sampling

Additional samples will be collected before and after flaring and at intervals of 3 days during the flaring operation. The samples will be collected not only at the Class B locations but also from the dairy near Meeker. Sample analysis will be expanded to include assay for ^{3}H by liquid scintillation.

7. Herbivorous and Aquatic Animal Sampling

Herbivorous, preferably species used by man as food (e.g., deer, cottontail rabbits, etc.) will be collected as available shortly before and after the flaring operation. Sample analysis will be expanded to include assay of moisture for ^{3}H by liquid scintillation. Additional fish samples will be collected from the Class A, 5 stations immediately before and after flaring. The samples will be gamma scanned and assayed for ^{3}H by liquid scintillation.

8. External Background Measurements

No change from Volume II.

9. Bioassays

One person regularly resident at each of the four locations in Class B will be requested to submit urine samples, one before and one immediately after the flaring operation. Additional samples may be solicited during flaring in the event of suspected exposure. All samples collected will be assayed for tritium activity by liquid scintillation.

B. SCHEDULE

Figure VIB-1 shows the projected schedule of activities.

C. SUPPORT REQUIREMENTS

None

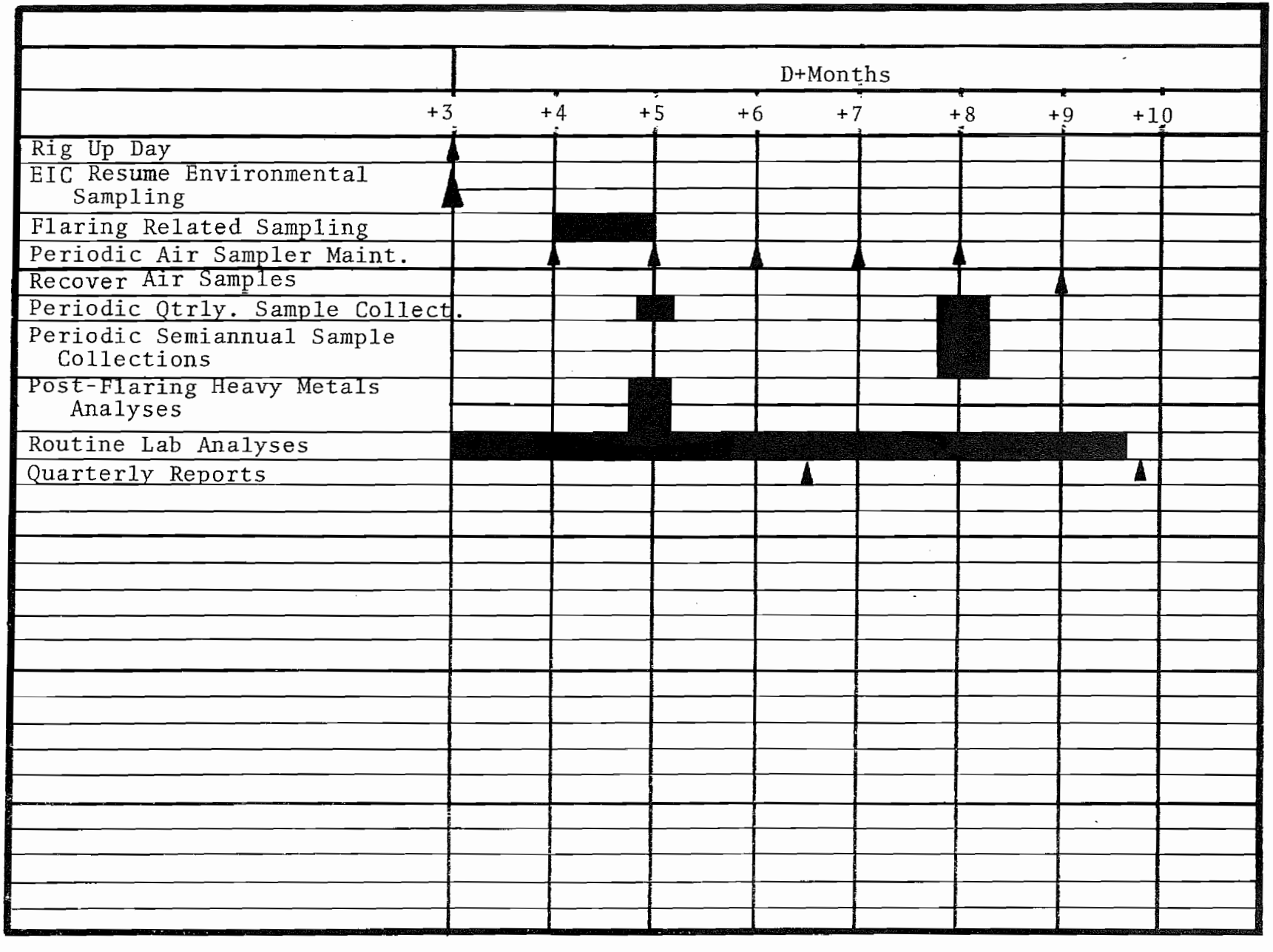

Figure VIB-1. Environmental protection plans and documentation schedule.

VII. PROGRAM MANAGEMENT

A. PLANNING AND ADMINISTRATION

1. CER Organization

The CER Project Director will be responsible for all functions that are not the responsibility of the Government and shall act as CER's representative in dealings with the Government. He may delegate his authority as required for the efficient operation of the project. CER shall establish and staff necessary organizational elements for conducting Project Rio Blanco. This staffing will provide for administrative functions in CER's Las Vegas office as well as Colorado field activities.

2. Government Agencies' Organization

a. The AEC, through the Manager, Nevada Operations Office (NVOO), shall provide an AEC Project Director responsible for control of those postdetonation activities defined in the NVOO Operations Plan. He shall further establish and staff the necessary organization elements to satisfy those responsibilities.

b. LLL will provide an Operations Director who will be responsible to the AEC for tasks delegated by the AEC through the Manager, NVOO. He shall provide the necessary staff to satisfy those responsibilities.

B. FIELD OPERATIONS

1. General

Field operations will center around two separate locations. The reentry drilling and subsequent testing activities at the EW on Fawn Creek and the administrative support functions at the CER office and warehouse complex in Grand Junction. The organizations involved and their probable locations are:

EW	GJCP
CER	CER Project Director
AEC	AEC Project Director
LLL	Office of Information
RSC	

2. CER Project Director

The CER Project Director and/or his designee will be at the project site prior to the reentry operations and remain through the flaring

and initial buildup activities. A Field Administrator and a secretary will be operating out of the GJCP.

3. AEC Project Director

The AEC Project Director will issue an operations order outlining general responsibilities for operational control during the reentry and production testing phase of the project. He or his designee will be on site during the critical portions of the activities.

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

a. Review and certification of provisions for safety of onsite and offsite personnel.

b. Compliance with all applicable nonlicensing regulatory requirements.

c. Management of AEC activities at the site.

d. Security control of any classified material until disposed of or shipped offsite.

e. Control of areas when radiological or industrial safety hazards may be present.

4. LLL Operations Director

The LLL Operations Director will provide technical and safety direction of LLL-directed operations, which include reentry drilling, well completion, and initial testing of the production testing system. It is not contemplated that this responsibility will extend into the routine production testing.

5. Support Authorization System

A support authorization (Buck Slip) system will be used to coordinate, through CER and its contractors, logistics support needed by LLL and the AEC. The LLL Operations Director or the AEC Project Director (or their designees) will authorize the required support on a Buck Slip. The Buck Slip will then be given to an authorized CER representative who will be responsible for providing the required support services.

C. TECHNICAL AND SAFETY REPORTING

The Technical and Safety Reporting Plan described in Volume II of the Project Definition Plan is applicable to the reentry-related tasks.

The following reports will be issued:

Project Rio Blanco Reservoir Test and Evaluation (LLL)*
Project Rio Blanco Reentry Drilling (CER)
Project Rio Blanco Operational Safety and Environmental Protection and Documentation Report (CER)
Project Rio Blanco Summary of Reentry Related Activities (CER)

D. SECURITY PROGRAM

No postdetonation security is planned at this time. However, in the event that security protection is required, it is anticipated that 24-hour protection would be provided by appropriately cleared administrative or guard personnel.

Procedures for safeguarding any postdetonation classified sample returns to the laboratories or other locations are the responsibility of the LLL's organization under conditions approved by the NVOO Security Division Director or the Security Chief.

E. SCHEDULE

CER Personnel will be in Colorado for 3 months, beginning 1 month prior to the planned reentry drilling. The remainder of the activity will be carried out in Las Vegas, Nevada. The project is expected to be completed 1 year after the start of testing. Reports will be issued until the issuance of the final report on or before D+30 months.

F. SUPPORT REQUIREMENTS

1. Transportation

One vehicle - 3 months
One vehicle (w/radiotelephone) - 2 months

2. GJCP

Office space (450 sq ft) at Grand Junction office
Two desks with chairs at Grand Junction office
Two telephones at Grand Junction office - 4 months
Reproduction facilities
One typewriter - 2 months

3. EW

AEC/LLL office trailer (8 x 40 ft)
120-vAC, 40-amp, 60-Hz power for AEC trailer

*CER will coauthor

VIII. PUBLIC AFFAIRS

The CER and AEC/NVOO Office of Information will continue to coordinate and disseminate information including issuing news releases and coordinating contact with the public. Communications will continue with Colorado State officials, local government officials, civic leaders, news media, and the general public in the Rio Blanco area and other areas of interest in the Rocky Mountain region. The intent is to explain the purpose of the postdetonation gas production testing program, describe and explain project activities, and respond to requests for information.

This task, which applies to all Project Rio Blanco participants including contractors and subcontractors of the participants, will continue until the testing phase has been completed.

Support Requirements:

1. Office and display area at GJCP
2. Part-time secretarial use
3. Reproduction facilities
4. Auto with commercial radiotelephone
5. Access to office equipment and miscellaneous office supplies
6. Miscellaneous requirements such as optical projection systems, printing, etc.

IX. ADD-ON PROGRAMS

In order to supplement the technical objectives of Project Rio Blanco, additional technical measurements have been planned by both LLL and CER. Most of these are detonation related and have been described in Volume II. The following programs are reentry related.

A. RADIOECOLOGICAL STUDIES (LLL)

The LLL Biomedical Division plans to conduct radioecological studies on the behavior of tritiated water vapor (THO) released to the environment at the Rio Blanco site during the flaring period, provided that the season of the year at production testing is appropriate for the proposed monitoring program. These experiments will be conducted in the vicinity of the flaring site where THO concentrations in the air will be high enough to trace the behavior of tritium in the environment. The LLL Biomedical Division will carry out a sampling program to determine parameters affecting the fate of the tritium released to the atmosphere, particularly those necessary for testing and augmenting the model of tritium transport and behavior which were developed from similar studies performed during production testing on Project Rulison. These parameters, which are basic to determining the radiobiological significance of any planned release of THO, previously have been studied under experimental field conditions at LLL as well as at the Rulison site. Additional field experiments were conducted at the Nevada Test Site in 1972 on the uptake of THO vapor by the same species of vegetation as are present at the Rio Blanco site. The data obtained in the LLL Biomedical Division studies have indicated that dose estimates made by a variety of organizations for Project Rulison were overly conservative by a factor of 10^3 to 10^4. Several parameters such as plant uptake and tritium half-times in vegetation were overestimated by an order of magnitude. Because these tritium half-times values are basic parameters used in the estimation of the radiation dose to man, it is important that they be realistic and not overly conservative, and it is highly desirable that they be determined in the actual ecological system being affected by the THO release.

The following measurements and determinations will be made in the program:

1. Deposition of THO vapor on woody, herbaceous, and graminaceous (grasses) vegetation; both native and agricultural species will be compared.

2. Deposition of THO vapor on bare soil surfaces.

3. Deposition of THO vapor in soil-plant systems.

4. The effective biological half-life of tritium in plant species and in the soil-plant systems which have received chronic exposure to THO vapor during flaring; these measurements will commence after flaring ceases.

5. The variability in the deposition of THO between species, and the variability observed in specific plants of the same species.

6. THO concentrations prior to, during, and after flaring will be described for at least one site; micro-meterological data will be obtained at that site and correlated with flaring data, air concentrations of THO, and the THO deposition data.

The program may be augmented by studies of deposition or uptake of other radionuclides; e.g., ^{203}Hg and ^{14}C, if they are present in detectable amounts.

B. OTHER INVESTIGATIONS (LLL)

The need for other investigations, such as the determination of fractures or auxiliary pressure measurements, will be assessed after production testing.

C. SCHEDULE

The radioecological program will be fielded from 5 days before start of the flaring program to 5 days after its completion.

D. SUPPORT REQUIREMENTS

1. Radioecological Studies

Spot 3-ton laboratory van at EW

250 ft^2 of trailer space suitable for liquid scintillation spectrometer and other small laboratory equipment.

Access to telephone

2. Other Investigations

None required.

X. SCHEDULE AND SUPPORT REQUIREMENTS SUMMARY

A. SCHEDULE

The schedule of the major items associated with the reentry related detailed tasks is shown by Figure XA-1.

B. SUPPORT REQUIREMENTS SUMMARY

The following is a list of the support items that will be furnished for the reentry-related tasks.

Item	For	GJCP	EW
Trailer, 10 x 40 ft	CER		X
Trailer, 10 x 50 ft	AEC/LLL		X
Trailer, 10 x 50 ft	Tool Pusher*		X
Trailer, 10 x 40 ft	Tool Hand**		X
Office Space	CER	X	
Office Space	AEC	X	
Trailer, 8 x 40 ft	RSC*		X
Trailer, 8 x 40 ft	RSC*		X
Trailer, 8 x 40 ft	RSC*		X
Trailer, TRY-KRY	CER		X
Trailer, 8 x 20 ft	CER		X
Electric Power	--	75 kw	150 kw
Telephone Lines	--	4	3
Propane	--		X
Control Station Radios	--	1	1
Remote Control Radios	--	2	5
Mobile Radios	--	24	X
Drinking Water	--	X	X
Non-Potable Water	--		X
Holding Tank	RSC		X
Electric Pump	RSC		X
50 Barrels (55 gal.)	RSC		X
Fenced Storage for Above	RSC		X
Vehicles	CER	12	
Vehicles***	AEC	7	
Vehicles***	LLL	14	
Desk, Exec. & Chair	--	9	3
Desk, Sec. and Chair	--		
Chair, Guest	--	28	12
Storage Room	--	1	
Conference Table	--	3	

*Contractor Furnished

**LLL Biomedical after reentry drilling

***CER will fund but AEC will administer. See Figure XB-1 for schedule details.

Item	For	GJCP	EW
File Cabinet	--	5	1
Reproduction Machine	--	1	
Side Table	--	4	
Bunks			as required
Display Board	--	5	
Blackboard	--	2	2
Bulletin Board	--	1	1
Typewriter	--	2	
Adding Machine	--	1	
Calculator	--	1	
Coat Tree	--	1	
Drafting Machine	--	1	
Table and Stool for Above	--	1	
Refrigerator	--	1	
Electric Heater	--	1	2
Fire Extinguishers (dry)	--	5	15
Office Supplies, Misc.	--	X	X
35mm Slide Projector	--	X	
16mm Movie Projector	--	1	
Screen for Above	--	1	
First Aid Supplies	--	X	X
Secretarial Help	--	X	

Figure XB-1 shows the expected site population during reentry and production testing. Figure XB-2 shows the expected vehicle requirements during the same period.

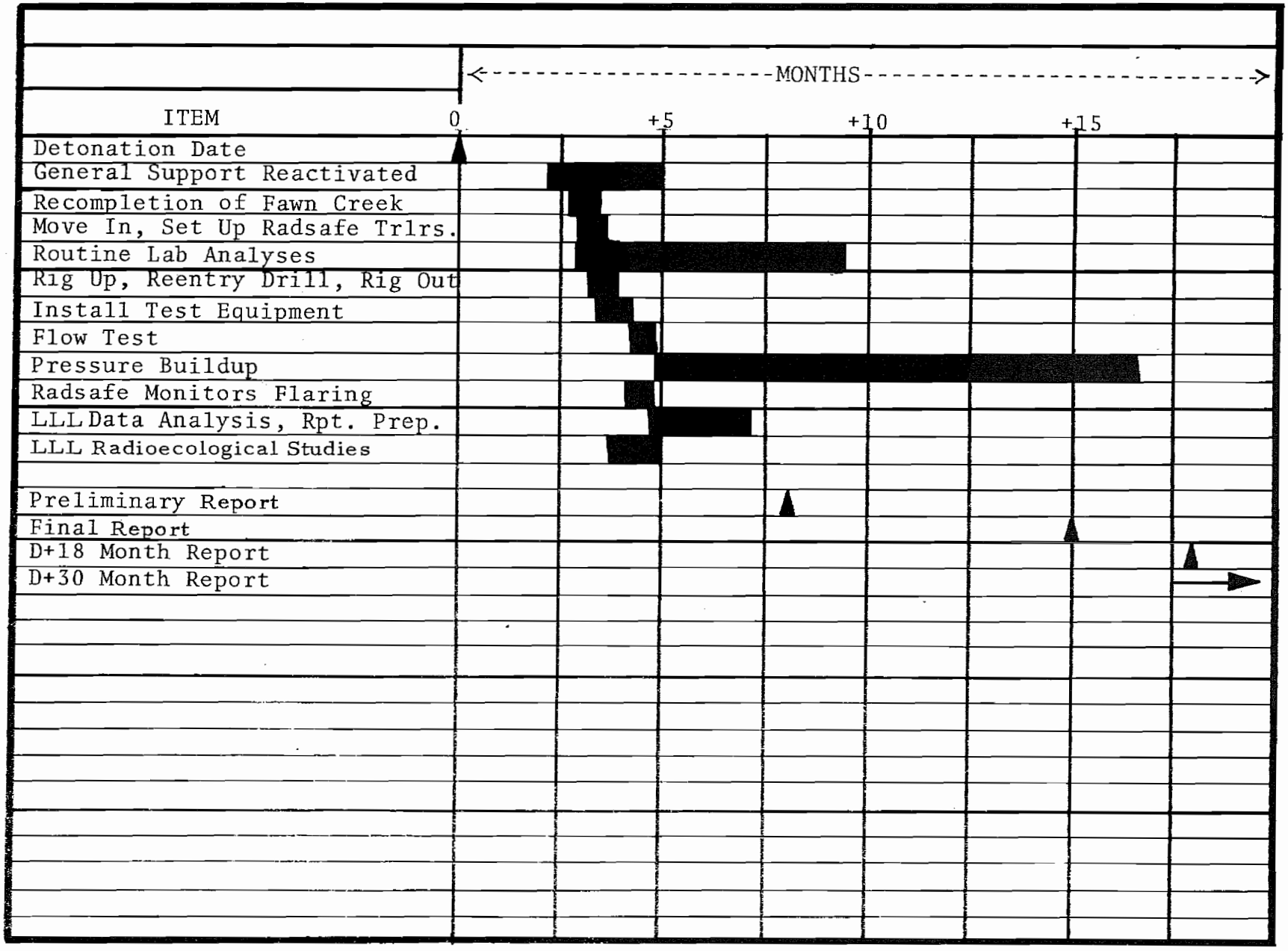

Figure XA-1. Schedule of major reentry-related tasks.

	WEEKS AFTER DETONATION												
	10	11	12	13	14	15	16	17	18	19	20	21	22
LLL	1	1	6	6	5	5	11	21	28	15	12		
AEC				3	6	7	5	2	4	5	5	1	1
CER	3	3	3	6	8	9	6	6	7	12	12	4	4
RSC	1	1	10	10	13	13	13	13	13	13	13	6	6
Total	5	5	19	25	32	34	35	42	52	43	42	11	11

Figure XB-1. Site population during reentry and production testing.

	WEEKS AFTER DETONATION												
	10	11	12	13	14	15	16	17	18	19	20	21	22
LLL	1	1	5	5	4	4	6	11	14	6	4		
AEC				3	6	7	5	2	4	5	5	1	1
CER	3	3	3	6	8	9	6	6	7	12	12	4	4
RSC			User Supplied										
Total	4	4	8	14	18	30	17	19	25	23	21	5	5

Figure XB-2. Vehicle schedule.

ABBREVIATIONS AND SYMBOLS

AEC	Atomic Energy Commission
BBL	Barrel
BHC	Bore hole compensated
BHP	Bottomhole pressure
BHST	Bottomhole stabilized temperature
BOP	Blowout preventer
BSCF	Billion standard cubic feet
BTU	British Thermal Unit
BWPD	Barrels of water per day
CER	CER Geonuclear Corporation
CFM	Cubic feet per minute
CSP	Colorado State Patrol
DAT	Division of Applied Technology
DWC	Drilling well control
EW	Emplacement Well
GPD/ft	Gallons per day per foot
GL	Ground level
GJCP	Grand Junction Control Point
^{3}H	Tritium
IF	Internal Flush
^{85}Kr	Krypton-85
LLL	Lawrence Livermore Laboratory
MCFD	Thousand cubic feet per day
MMSCFD	Million standard cubic feet per day
NVOO	Nevada Operations Office
PNE	Peaceful Nuclear Explosives
RAMS	Remote Area Monitoring System
RSC	Radiological Support Contractor
RTTS	Halliburton's retrievable test-treat-squeeze tool
SCF	Standard cubic feet
TD	Total depth of well
TLD	Thermoluminescent Dosimeter
TRY-KRY	Tritium and Krypton Radiation Measuring System
VHF	Very high frequency