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I. Reference Materials

The following is a list of reference materials useful in pipeline planning, design and construction.

a. Engineering Field Manual
b. Supplement to Engineering Field Manual, Chapter 3 (Hydraulics)
c. Section IV Technical Guide, Practice Standard 516, Pipeline
d. Section IV Technical Guide, Practice Standard 614, Troughs and Tanks
e. North Dakota Construction & Material Specifications for Conservation Practices
f. ASTM and AWWA Standards
g. King's Handbook
h. National Range Handbook, Section 1000
i. Section IV Technical Guide, Practice Standard 528, Proper Grazing Use

II. Site Investigation

The following is a list of items to be checked in the field:

a. Have alternative practices been considered such as wells, ponds, and springs?

b. Does the planned pipeline provide for an economical and practical system considering source, delivery pipe and drinking or storage facilities?

c. Does pipeline facilitate conservation of forage resources by improving the distribution of livestock grazing or does it provide water for recreational use?

d. Does the proposed pipeline route encounter high water table, rock strata, buried utilities or surface improvements?

e. Is the quality and quantity of the water source adequate for present and future needs? If potable, can the water be economically treated to meet sanitation requirements?

III. Design Surveys

Survey information shall be obtained and recorded in Loose-leaf (SCS-ENG-028 and SCS-ENG-029) or bound field notebooks. Survey notes will be kept similar to the format in Technical Release 62 and Chapter I, Engineering Field Manual. The degree of survey required will be determined by the approving individual based on the complexity of the pipeline.

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Survey and data gathering items to consider are:

a. Profile along centerline (measuring wheels, altimeters, topographic maps and levels are acceptable tools for obtaining this information; but, must be checked in the field for accuracy at critical elevations).

b. Topographic surveys as needed (where topography requires grade control for installation, physical obstructions, property lines or improvements are encountered).

c. Static and drawdown water elevations of the well at proposed or designed flow rate, type and diameter of casing, age of well, well log and depth. Similar information must be obtained for lakes, streams, springs, and other sources as applicable.

d. Items such as existing power source for pumping, type and size of pump, motor size, storage facilities, pressure switch and setting, pressure tank, well log, whether potable use or not, existing piping, etc. as required do design the system.

IV. Design Data

The following steps are considered the minimum required to design a pipeline. Quality of water source is assumed previously checked. Steps are not necessarily in order.

a. Determine pipeline capacity and storage requirements. The pipeline is only as good as its source of supply. Capacity of the well or spring often is the limiting factor. Records, such as well drillers pump tests and landowner experiences regarding a source, are needed and should be documented. Dependability of source may be related to the method of pumping. Both limited water supply and potential power shortages must be addressed.

b. Complete hydraulic design for diameter, class, and grade of pipe. Consideration should be given to designing on two-thirds of the certified working pressure when water hammer is expected to be encountered due to rapid valve closing times, pump starts, or line length. Correct plastic pipe pressure rating for water temperature if substantially different from standard values using appropriate charts.

c. Plot centerline profile on standard sheets. Plot static and hydraulic grade lines above profile.

d. Design appurtenance size, location, and type. Pressures must be maintained within operating range of all valves, pipe, fittings, etc., used on the system. The following appurtenances are common to pipeline designs.

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Vents - Vents consist of open pipe risers generally with 180 degrees return bend, to allow air to escape from the pipeline during filling or to enter whenever necessary to prevent vacuum. A vent should be installed at least one-half to one foot from the inlet, depending upon pipe diameter and water velocity. The minimum distance, L, in feet, can be computed from the formula:

$$\text{Min } L = 1.76\ VD$$

where V is the average water velocity in feet per second and D is the diameter of the pipe in feet. Vents may be used in place of air release valves if the static water level is not higher than the top of the vent. It is recommended that vents extend not more than four feet above ground level.

Valves

Air-Release Valves - An air-release valve is a continuous acting valve that has a small venting orifice, generally ranging between 1/16 in. and 3/8 in. in size. This valve releases pockets of air from the pipeline during filling and also after the line is filled and under working pressure. A minimum of one air-release valve should be located on the first summit from the water source. Manual air-release valves or hydrants may also be used to vent air. Placement of hydrants at highest pipe elevations can reduce the number of air-release valves needed.

Air-Vacuum Valve - An air-and-vacuum valve, which has a large venting orifice, exhausts large quantities of air from the pipeline during filling operations and allows air to reenter the line and prevents a vacuum from forming during emptying operations. This type of valve is sometimes called air-vacuum-release valve or air-vent-and-vacuum-relief valve. It is not continuous acting because it does not allow further escape of air at working pressure once the valve closes.

Combination Air Valve - A combination valve is sometimes called combination air-release and air-vacuum valve or combination air-and-vacuum-relief valve. It is continuous acting and combines the functions of both the air-release valve and the air-vacuum valve.

Pressure-Reducing Valve - A pressure-reducing valve automatically reduces the pressure in a pipeline on the downstream side of the valve. It is used to maintain satisfactory working pressures and allows use of pipe with lower pressure rating. Variable inlet pressures can be substantially reduced to a constant outlet pressure.

Check Valve - A check valve should be installed between the pump discharge and the pipeline, and as needed on the pipeline where backflow could damage the pump or pipelines.

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Pressure Tanks

Pressure tanks, where pressure switches are used to control pumping, should be large enough so the pump will recycle a maximum of six times per hour when pumping the average rate needed to supply the maximum daily use.

Other Appurtenances

Storage and surge tanks, screens, strainers, switches, timers, drain valves, float valves, hydrants, and numerous manual or automatic valves are available to serve a variety of functions. All appurtenances should have a minimum rating, grade, and be of compatible material as the pipeline they control.

a. Compute Quantities. At this time, review design to ensure completeness. Check for pipeline adequacy, freeze protection, compatible appurtenances, surge protection, waterbar placement, pump requirements and design, backfill requirements, and requirements for sanitation and certifications.

A partial list of critical items follows:

Pumps and Motors

See Chapter 12, Engineering Field Manual, for information on pumping systems. The selection of the motor to operate the pump shall be based on power requirements and availability at the site. Pump selection is based upon required capacity, total lift, and diameter of well. Common pumps are centrifugal, vertical turbine, submersible turbine, mixed flow, jet, and reciprocating. Power required to run the pump is determined by the amount of water to be pumped, the height to which it must be pumped (including the depth to water in the well at drawdown, operating pressure, plus the total friction loss), the efficiency of the pump and drives, and a power factor (normally about 94%).

$$Bhp = \frac{Gpm \times total\ head}{3960 \times pump\ efficiency \times drive\ efficiency \times power\ factor}$$

Where bhp is brake horsepower.

The total head and gallons per minute are to be included on the drawings. This information can be used by the owner and the supplier for selection of the proper pump and power unit.

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Existing Pipeline Extensions

When tying on and extending existing pipelines, pipe diameter, type and pressure rating of the old line is needed. Working pressure of the old line, appurtenances, and elevations along the line at all critical locations are required to ensure compatibility with proposed extensions.

V. Construction Plans and Specifications

A set of plans and specifications for the pipeline construction will be given to the cooperator and contractor, and a set placed in the cooperator's file. On smaller systems, Form ND-ENG-018 can be used for complete documentation. Larger and more complex jobs will require appropriate "E" and "N" sized sheets.

The final plan for the pipeline should show:

a. A ground surface profile along the centerline of the pipeline. Identify and show ground elevations at all appurtenant locations.

b. Profile of maximum static and hydraulic grade lines for design conditions. Also, show grade lines needed for any special operating conditions.

c. A plan view of the pipelines showing stations and important appurtenance locations.

d. Quantities listed by amounts and types of material used in the installation.

e. Special instructions needed for the installation.

f. Signatures of responsible persons.

It is recommended that a contractual agreement be entered into between the cooperator and the contractor. This agreement can be either formal or informal. It is also recommended that the agreement contain a requirement that the contractor guarantee the pipeline against defective workmanship and materials for a period of one year from the date of installation.

VI. Layout

Layout surveys, when required, will be kept in the same format as described for design surveys.

As a minimum, pipeline alignment and location of appurtenances shall be marked and recorded. The route need only be flagged if elevations are not critical. Offset cut stakes and similar layout of critical items will be recorded where required.

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VII. Compliance Checking - "As-Built" Plans

The complexity of the pipeline will dictate the need for compliance checks during construction. All compliance checks shall be recorded in field notes, and/or appropriate forms or plans. Compliance checks shall include, as a minimum, the following:

a. Profile and depth of pipeline.

b. Location, size, and type of appurtenances.

c. Pipe length, diameter, type, class or pressure raging.

d. Results of pressure test(s).

"As-built" plans shall be prepared for all pipelines. "As-built" drawings will reflect significant changes in linear measurement, quantities, alignment, or design changes. The original drawing may be used for "as-built" plans as long as changes are in a contrasting color or otherwise marked for clarity.