10. Switchyards and Substations. The Introduction (Chapter 1) for these design data collection guidelines contains additional information concerning: preparing a design data collection request, design data collection requirements, and coordinating the design data collection and submittal.

A. **General Map showing:**

(1) A key map locating the general map area within the State.

(2) The structure site or sites.

(3) County and township lines.

(4) Existing towns, highways, roads, railroads and shipping points, public utilities such as electric power and telephone lines, pipelines, etc.

(5) Locations of potential construction and permanent access roads, a sites for contractor's staging areas and construction facilities.

(6) Locations of borrow areas for natural construction materials and disposal areas for waste excavation.

(7) Existing or potential areas or features having a bearing on the design, construction, operation, or management of the project feature such as: recreation areas, fish and wildlife areas, building areas, and areas of archeological, historical and mining, or paleontological interest. The locations of these features should bear the parenthetical reference to the agency most concerned; for example, Reclamation, NPS, or FWS.

B. **General Description of Local Conditions Covering:**

(1) The approximate distance from the nearest railroad shipping terminal to site; load restrictions and physical inadequacies of existing roads and structures and an estimate of remedial improvements to accommodate construction hauling; estimate of length and major structures required for new construction access road; and possible alternative means for delivering construction materials and equipment at the structure site.

(2) Local freight or trucking rates.

(3) Availability or accessibility of public facilities or utilities such as: water supply; sewage disposal; and electric power for construction.

(4) Climatic conditions that will affect design, construction, and operation and maintenance procedures such as: amount, rate, and distribution of rain and/or snow; ice conditions; summer and winter temperatures, with extremes; extreme wind velocities and prevailing directions; floods; and probability of excessive dust or sand.

C. **Surface Data:**

(1) A topographic map:

(a) Covering an area that will accommodate all expected arrangements of facilities, and rights-of-way, and extending sufficiently to allow for control and disposal of drainage at the site and to indicate the general drainage of the vicinity.

(b) Normally at a scale of 1 inch equals 50 feet.

(c) Giving elevation above sea level and having a contour interval between 1 and 5 feet.

(d) Giving dimensions and bearings of the property lines, and a dimensional tie to a known section corner.

(e) Showing the suggested location of all facilities.

(f) Showing the direction and relative order of all transmission lines and other existing facilities within the area.

(2) Color photographs:

(a) Taken from a high oblique angle, showing the area covered by the topographic map. (Aerial photographs if practicable.)

(b) Closeups showing any features which may affect design; photographs of existing facilities, especially in the vicinity of additions; and any facilities or structures which are to be revised.

(3) Vegetation to be cleared:

(a) Include kinds, sizes, and density of growth of trees and brush.

(b) Include depth of stripping required to remove organic matter or objectionable material.

(4) Seeding or replanting requirements for erosion control or aesthetics.

D. **Foundation Data:** The following data should reflect a recognition of the requirements for switchyard and substation structures and foundations. Maximum loaded structures are the towers which support and anchor electrical conductors and buses, and overhead ground wires. Foundations are required to resist uplift, horizontal, and compression loads with very little movement. Foundations will normally be less than 10 feet deep and seldom greater than 20 feet deep. The sites are normally leveled by balancing the cut and embankment. The TSC geologic and geophysical staff will provide necessary assistance and guidance in the gathering of these design data.

(1) **Geologic Data:**

(a) A description of site geology including physical quality and geologic structure of the foundation strata, seasonal ground water, and seismic conditions, existing and potential landslide, snowslide, and rockfall areas, expansive clays, possibility of frost heave, and engineering geologic evaluations appropriate to the engineering structures involved. Non-Bureau geologic investigations and reports should be referenced.

(b) Geologic logs of all subsurface exploration. The coordinate location and ground surface elevation of all existing exploratory holes should, if necessary, be corrected to conform with the permanent survey control system; and all subsequent exploratory hole locations and elevations should be based on the same survey control system.

(c) A geologic map, plotted on the topographic map of the site, showing surface geology and the location of geologic sections, soil profiles, and all subsurface exploration.

(d) Geologic sections, with detailed soil profiles as required, showing known subsurface conditions.

(e) Views of pertinent geologic and topographic features should be included in the color photographs required by paragraph C (2) above.

(f) Samples of foundation strata as needed for visual examination or laboratory testing.

(2) **Engineering Data:**

(a) Soils (see *Earth Manual*, latest edition).

- Foundation exploration should include penetration resistance tests in accordance with Field Penetration Test With Split-Tube Sampler, Designation E-21, *Earth Manual*, latest edition, in materials in which the test is applicable. Relative density tests should be made in soils in which the Field Penetration Test is not applicable. In-place density and plasticity tests (liquid limit and plastic index) would be applicable in suspected expansive soils. All holes should be carried to 20 feet below the estimated final yard grade. Where penetration resistances are less than 15 blows per foot at the 20-foot depth, holes should be 60-foot-minimum depth or at least 5 feet into material having a penetration resistance of 30 or more blows per foot, whichever occurs first.

- Test holes, advanced by augering and without penetration testing, or test pits may be used as required to supplement any of the above exploration, to verify similarity of materials, and to determine depth to bedrock. Bedrock may be encountered at or near the ground surface that cannot be penetrated by penetration testing. In such cases, report whether the bedrock can definitely be expected to extend at least 20 feet below the ground surface. If it is believed that bedrock does not extend 20 feet deep, test holes must be advanced to a depth of at least 20 feet below the ground surface.

- A description of the undisturbed State of the soil in each major strata. Comment on the capability of the material to stand in sides of the hole if augered and undercut for an auger foundation.

- A delineation of the lateral extent and thickness of critical, competent, poor, or potentially unstable strata in foundations and excavation slopes, especially those to be permanently exposed.

- An estimate or a determination by tests of the significant engineering properties of material, such as density, plasticity, shear strength, and consolidation or

expansion characteristics; and the effect of changes in Moisture on these properties.

- Describe conditions which may affect construction methods such as boulders on the ground surface, drilling conditions, stability of test holes, and marshy or subsiding ground.

- A determination by tests of the corrosive properties and sulfate content of earth materials and ground water as affecting the choice of cement.

(b) Bedrock (see *Earth Manual*, latest edition).

- If sufficient data exists, a contour map on top of bedrock if encountered in explorations. A description of thickness of weathered, altered, fractured, or otherwise softened zones, and other structural weaknesses and discontinuities.

- A delineation of structurally weak and potentially unstable zones and strata of soft material in foundations and excavation slopes, especially those to be permanently exposed.

E. **Corrosion Survey.**

(1) In situ electrical resistivity measurements of geologic materials in the area of construction. Additional measurements should be made in the areas where there is a pronounced change in type of geologic materials, drainage, and/or moisture conditions.

(2) Performance history of materials of construction that have been used in the area.

(3) List of structures in the vicinity of (within ¼ mile) the proposed structure and appurtenant features. Determine if buried structures in the vicinity have corrosion protection and, if so, the type of corrosion protection.

(4) List location, output, and purpose of the direct-current sources in the earth situated within ¼ mile of the proposed structure and appurtenant features. If the purpose of the direct current is for cathodic protection, describe the structure protected and its location.

(5) Chemistry of geologic materials, ground water, and/or product water.

F. **Construction Materials Data including:**

(1) Location of and distance to suitable borrow areas for soil materials for fill or embankment. If quantities are limited, give approximate volumes available.

(2) An earth materials report containing information on those potential sources of soils that have been selected for final consideration. (See Earth Manual latest edition.)

(3) Data on commercial concrete plants within practical hauling distance from the structure site.

(4) Results of sampling and analysis of potential concrete aggregate and other materials, including previous tests conducted at the TSC.

G. **Data at Existing Facilities:**

(1) Report any measurable or indicated movement of foundations.

(2) Comment on the suitability and present conditions of yard surfacing.

(3) Report any erosion or drainage problems within or adjacent to the substation which should be corrected.

(4) Report any problems encountered during previous construction or during operations and maintenance.

H. **Electrical Data:**

(1) Switching diagrams showing suggested circuits including all major equipment proposed such as transformers, circuit breakers, and regulators. Where equipment is to be purchased and installed by the Reclamation for the use and benefit of an interconnecting system, with the Reclamation being reimbursed for such installation, comments pertinent to such arrangements should be included as part of the design data.

(2) Capacity of all transformers in kilovoltamperes.

(3) Data for all circuits:

(a) Nominal voltage and destination.

(b) Loadings in kilovolt-amperes or kilowatts and power factor.

(c) Data to determine the type of metering required for each foreign line. (Indicating watt-hour demand meters will be provided unless otherwise specified.)

(d) Size of conductor for existing or foreign line.

(e) Phasing of existing and foreign lines at station.

(f) Minimum voltage during heavy load and maximum voltage during light load for both normal and emergency conditions.

(g) Names and telephone numbers of owners for each foreign line and contacts within their organizations.

(h) Connection agreements with utility transmission operators.

(4) Single-line diagram of foreign primary systems which will connect to Reclamation station. This information is required for relay studies and should include the following:

(a) Location of primary system circuit breakers and relays as contemplated for initial operation. Future changes should be indicated where possible.

(b) Type of primary system relays (distance, overcurrent, etc.) and the relay operating characteristics. The actual relay settings will be required to make coordinating settings of Reclamation relays, but these data need not be provided initially if it will delay receipt of other information. Relay coordination problems, such as slow relaying on primary system, should be presented.

(c) Primary system operating conditions which may affect Reclamation relaying or control.

(d) Reclosing time if automatic reclosing breakers will be used on the primary systems.

(e) Length and characteristics of primary lines and whether they are three-wire or four-wire circuits.

(f) Location, connections, and rating of transformers and synchronous machines which connect to the primary

systems. The locations and type of neutral grounding should be included.

(5) Proposed method of operating station, whether attended, unattended, or supervisory controlled.

(6) Heights and locations of existing buildings, transmission lines, and other obstructions which are not associated with the station but are in or near the station site and will present clearance problems.

(7) Type and extent of communication facilities desired.

(8) Capacity charge, energy charge, interest rate, and plant factor to be used in evaluation of transformer losses.

(9) Requirements for lighting for night operation or security purposes.

I. **Building Facilities:**

(1) Service building and maintenance building.

(a) Space requirements for equipment, office, work area, vehicles, and storage.

(b) Minimum door opening sizes.

(c) Water supply and toilet facility requirements.

(d) Air conditioning, heating, and ventilating requirements.

(e) If an existing building is to be replaced, comment on disposition of existing buildings and work to be accomplished by the project.

J. **Environmental Considerations.** Design data should include, as a minimum, a brief description of the environmental commitments listed in the NEPA compliance document that could be affected by the proposed development. The emphasis should be on those areas in the range of alternatives open to the designers in developing a structural design. The following items should also be considered in preparing design data:

(1) The environmental setting.

(2) Cultural (historical, archeological, architectural, and paleontological) resources within the project area.

(3) The need for blending structures with the surroundings, restoring borrow areas, and reseeding spoil banks.

(4) The need for a field conference to resolve critical environmental problems with participation of other agencies.

(5) Review of designs by other agencies.

(6) Anticipated public use around the structure.

(7) Indicate the suitability and possibility of developing Government land adjacent to our facilities for use by the public for recreation, hobbies, sports, leisure, education, health, etc.

(8) Comment on any ecological, aesthetic, or other environmental aspects peculiar to this location which would affect layout or conceptual design.

(9) Refer to the specific requirements of the Environmental Criteria for Electric Transmission Systems by the Departments of the Interior and Agriculture.

K. **Site Security.** Many Reclamation projects may require a security risk assessment. The need for a site-specific security risk assessment should be considered for feasibility designs where an assessment may impact the field cost estimate and for specifications designs. Specific issues to consider are contained in Section 14 of Chapter 7 – Site Security and Public and Worker Safety. If assistance is required to determine specific design data needs, contact the Office of Security, Safety and Law Enforcement. Where design data and designs include site-specific security assessment, compliance with Reclamation Manual DM Part 444 – Physical Protection and Facility Security, Chapters 1 and 2 is required.