The speed of the CP is of major importance as it affects the rate of precipitation, which should not be identical to the irrigation dosage (water application). Then the irrigation dosage can be applied in several laps. As a rule of thump the minimum water application per irrigation cycle should be taken above 30 mm.

When water is pumped into the CP system, water fills the Lateral pipeline and the "hose drops". Weight of the water causes the pivot to squat especially toward mid-span. Length of the "hose drop" should be regulated to account for the change so that all emitter heads will be same height above ground when the system is running.

The Site Selection Criteria

The criteria to the collection and preparation of the above information are based on the kind and the type of the irrigation system and its techniques. A thorough study of the previous text specifies the site selection criteria for the installation of the CP irrigation systems as follows:

Area, size and shape

The area should be relatively level. This practice is usually applied in cereals for supplementary irrigation during drought periods.

Topography

The CP irrigation systems can operate on uneven ground; however, level lands are recommended and uniform sloping fields with slopes up to 3 percent. Undulating topography may produce a lot of difficulties especially where runoffs occur.

Type of soil

The soil should be of medium to light texture with high infiltration rate >15 mm/h and good internal drainage.

Water and pressure availability

The source of water can be a tube-well, a river, a small water tank. But the circular CP systems should be fed from a hydrant placed near the pivot. A booster pump can deliver the flow at the required pressure. The system inlet is connected to the hydrant through a quick coupling flexible hose.

Water quality

The water should be of normal pH, free from suspended solids, salinity hazard, sodium hazard and toxicity problems caused by bicarbonates, nitrates or boron. TDS should not exceed 1 500mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, boron content< 0.7 mg/l.

Fuel requirements

The CP systems are equipped with generators for driving the towers and booster pumps, both diesel engine driven. The fuel tanks must be connected with additional bigger tanks placed nearby for long uninterrupted operation of the CP systems.

Kind of crops

Winter Crops (Wheat, barley, Chickpeas, Lentils) Industrial Crops (Soybeans, Maize, Sunflower), Other Crops (Leafy Vegetables, Groundnuts, Watermelons, Lucerne etc.) (Figure 10.9).

FIGURE 10.9 - Overview.

EXAMPLE DESIGN

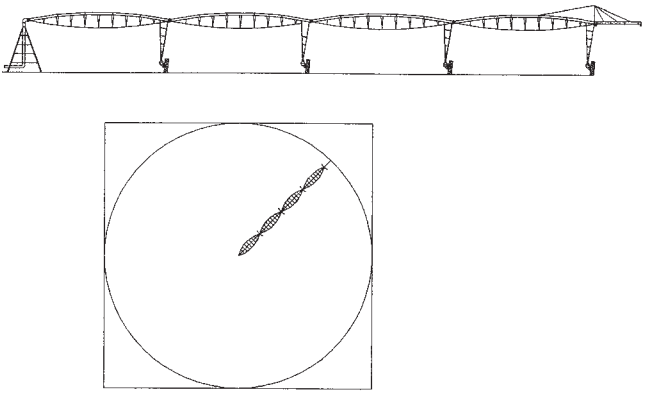
The design of the CP irrigation project is relatively simple and in any case easier than the conventional drip systems. This example design is a most difficult case. A summer field crop is selected in a semiarid area with high evapotranspiration and scarce water resources. The main steps are as follows:

- Determination of the irrigated area, the length of the CP radius and the crop main characteristics (root depth, growing season, critical stages etc.).
- Calculation of the crop irrigation requirements at peak demand and soil available moisture (water holding capacity)
- Irrigation schedule (dosage, daily operating hours and interval)
- System main characteristics and technical specifications

Area, CP radius and crop

The area is around 15 ha, with minor slopes. The length of the CP pipeline is 215 meters with effective wetted length with the end gun 218.5 m (circle radius). The periphery of the circular area is around 1 350 m (Circle circumference = $2 \pi r$) (Figure 10.10). The area is planted with groundnuts (Arachis hypogaea); it is a sensitive crop and any water stress results into yield reduction; growing season April–September, 130 days approximately; effective root depth 0.65 m.; kc values 0.45 initial stage, 0.75 vegetative growth, 1.0 at flowering and yield formation, 0.75 at the late stage. Mid-season stage is around 45 days with kc 1.0 and falls into July/August with the irrigation water demand at peak.

FIGURE 10.10 - System layout.



Crop water requirements and soil

Highest ETo in July-August is around 7.0 mm/day multiplied by crop kc 1.0, then ETc is 7.0 mm/day. The system application efficiency is 85 percent, so the gross irrigation needs are 7 mm ÷ 0.85 = 8.2 mm/day or 8.2 mm *x* 10 *x* 15 ha =1 235 m^3/day at peak demand period. Soil is light – medium texture with available moisture (Sa) 120 mm/m soil depth and infiltration rate > 15 mm/h. Based on the above data a detailed irrigation program (schedule) can be prepared.

Systems characteristics

The systems performances should meet the peak demand period as well as with the other growing period and the prevailing conditions with regard to the water availability, daily operating hours cost of fuel etc. The factors and data needed for the calculation of the system flow are the irrigation dosage and the daily water requirements. The dosage (d) = Soil available moisture mm/m (Sa) *x* moisture depletion percent (p) *x* root depth m (D). The frequency of irrigation in days is d mm ÷ Etc/day. The interval between irrigations (end of one irrigation until the beginning of the next) is the frequency in days minus the days required for fulfilment of one irrigation. The latter depends on the size of flow and the daily operating hours. In most cases the available flow dictates the basic system characteristics and performances. Irrigationists should take into consideration that the designed flow in practice is available only in 7 percent to 9 percent of the cases.

A system flow around 15–17 l/s (60 m^3/h) is selected and the minimum daily operating hours to meet the demand at the crop mid-season stage is:

$$1\ 235\ m^3/day \div 60\ m^3/h = 20.5\ h/day.$$

For one lap per day the speed time is 1.125 m per min. With two laps per day the speed is 2.25 m/h and the time per lap 10 hours and 15 minutes.

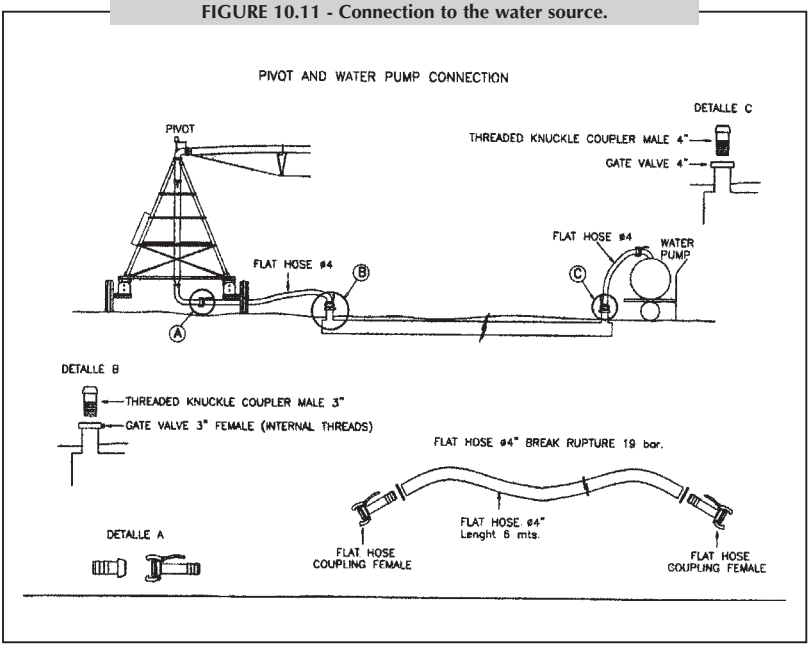
MINIMUM SPECIFICATIONS FOR THE CENTER PIVOT SYSTEM

The general CP system characteristics

- System Component parts: a) Pivot tower with Control Panel, and Generator, Towable on swivel wheels – b) Pipeline with sprayers on Hose drops and end gun, supported by self-propelled wheeled Towers (4), – c) Booster Pump with engine. d) Length of spans 40–50 meters. Minimum crop clearance 3.0 meters.
- Length of Pipeline: 216 m (4 spans of approx. 48 m + 24 m overhang)
- Length of wetted Radius: 219m approx.

- System Flow: 60 m^3/h
- Pressure at the Pivot Inlet: 2.3 Bars approx. (Figure 10.11)
- Area coverage: 15 ha approx.
- Min. speed, Time per Lap, Precipitation: 0.3 m/min., 74 hours, 29.6 mm
- Max. speed, Time per Lap, Precipitation: 3 m/min., 7.4 hours, 2.96 mm

FIGURE 10.11 - Connection to the water source.



The technical specifications

The central tower

Heavy-duty structure, hot dip galvanized including the elbow. Braces on all sides and Access ladder for checking the Collector ring. Appropriate size of riser inlet tube for minimum friction losses. Tower on swivel wheels and heavy-duty feet in cases of anchoring the pyramid to the concrete base. Galvanized Main Control Panel support angles. Pressure gauge. Riser-pipe support angles. No vibration of the inlet water with high pressure.

The pipeline

Hot dip-galvanized steel zinc coated inside and outside. Pipe diameter approx. 141–160 mm for minimum friction losses, min. PN 10 Bars. Rubber

gaskets, galvanized steel holders, short reinforced cardan type union of spans for great resistance, rubber union sleeves with steel clamps or aluminum couplings, flanged type of jointing of spans. All structure hot dip galvanized for preventing corrosion, unions with security bolts and nuts.

The water emitters

Low pressure sprayers with relatively large diameter coverage with interchangeable nozzles for various performances; equipped with individual pressure regulators on flexible hose drops sets for various crop clearance of 2–2.5 meters.

The driving towers

All the structure hot dip galvanized, with heavy duty tower legs, fixed to the pipe line, with braces on both sides and heavy duty train shaft supporting the gearboxes, the towers legs and the power drive. Drive units legs must be integrated on into the gearbox mounting and not on the free pipe.

The drive unit

Compact unit equipped with cooling fins, aluminum body, external dust seals to protect oil seals Tension 380 v. Frequency 50 Hz, rate: 40:1. Horse power ¾. Heavy duty Wheel Gearbox. Double side Output Shaft. Worm gear rate: 50:1. Drive Shaft with the transmission system based on a telescopic cardan joint, with steel crosses arms and protective casing.

The alignment system

Plastic Tower box anticorrosive with safety micro switches. Stainless steel internal support for electric components. Alignment components on stainless steel and aluminum. Individual electricity switch on every control box.

The control panel

Closed Box reinforced, double door, airtight totally isolated interior, Tension 380 V. Frequency 50 Hz. Including voltmeter, several pilots indicating control tension, support tower alarms and lack of pressure, control indicator forward and reverse running, forward and reverse selector, with or without water selector, automatic shut down (when pressure is insufficient), tension tester, hour counter, speed control, general switch. Possibility of stopping the electric generator electro valve or the water pump station in case of any problem during the pivot work. Outlet available for 24 and 110 V.

Collector ring

Totally sealed placed on top of the central pivot tower.

Wheels

Wheels for Irrigation use. First use High flotation wheels. Hot dip galvanized rims, with valve protection.