U. S. Army Corps of Engineers
Liquid Piping & Pumping Systems
Checklist

Installation Name	_____
Site Name / I.D.	_____
Evaluation Team	_____
Site Visit Date	_____

This checklist is designed to facilitate the performance evaluation of liquid piping and pumping systems. It is divided into the following sections:

1) Evaluation team composition
2) Typical treatment objectives
3) References
4) Data collection requirements
5) Performance analysis calculations
6) Adequacy of operations and maintenance
7) Typical performance problems
8) Alternatives for possible cost savings
9) Supplemental notes and data.

The checklist provides suggestions for information gathering, and space has been provided to record data and notes from the site visit. Supplementary notes, if required, should be numbered to correspond to the appropriate checklist sections.

1) Evaluation Team Composition

The following disciplines should be included in the evaluation team for the pumping and piping systems.

- Process Engineer (site visit, piping and pumping performance evaluation)
- Mechanical Engineer (piping and pumping systems evaluation)
- Cost Engineer (cost of alternatives)

2) Typical Treatment Objectives

Verify that the treatment objectives established when the pumping and piping systems were designed and installed are clear and still valid.

Piping and pumping systems serve the treatment process by moving the liquid process streams. The performance of these systems is effected by presence of gas or solid particulates in liquid stream. Filters and separators induce pressure drop and can effect the flow rate and pumping power required. A poor match between piping dimension and pump type and capacity can alter flow-regimes and induce phase separation within the treatment process.

The operational and maintenance costs of a pumping system can require significant financial commitment over the long term. Efforts should be made to implement actions that will reduce the operations, maintenance, and monitoring costs for this system.

3) References

Coordinate this checklist with the appropriate treatment technology checklists, and with the Process Instrumentation and Control checklist. Review the operations and maintenance manuals specific to the pumps and valves associated with this system. The following references may also be helpful:

CEGS 15200 [1]: Pipelines, Liquid process
CEGS 11211 [1]: Pumps, Water, Centrifugal
CEGS 11212 [1]: Pumps, Water, Vertical Turbine
CEGS 11310 [1]: Pumps, Sewage and Sludge
CEGS 13110 [1]: Cathodic Protection System (Sacrificial Anode)
TM 5-811-7 [2]: Electrical Design, Cathodic Corrosion Protection
EM 1110-1-4008 [3]: Liquid Process Piping

4) Data Collection Requirements

Review the performance of each individual piping system, including valves, pumps and instruments. Record the following information needed to run performance calculations and to check the operation of the piping and pumping system. Record the appropriate units with each value.

a) Record the nameplate information from the pumps, and other mechanical equipment for future reference.

_____

_____

b) Sketch process flow diagram (PFD), including valves, pumps, process equipment, tanks, and instrumentation, on the back of this sheet or a separate sheet.

c) Piping Data

Piping identification						
Pipe size						
Material of construction						
Fluid Pumped						
	Max.	**Avg.**	**Min.**	**Max.**	**Avg.**	**Min.**
Flow rate						
Pressure						
Temperature						

d) Verify the accuracy of <u>as-built</u> Process Flow and Piping & Instrumentation Diagrams.

_____

e) Are all valves and pumps operable? Are any valves or pump seals leaking?

_____

_____

f) Are the valves and valve operators accessible? Are any valves difficult for the operator to reach or manipulate? Are there any safety hazards resulting from the locations where valves were installed? Are the valves of the appropriate type for the system and fluid. (e.g., are corrosion resistant materials of construction used.)

_____

_____

g) Are the pumps an appropriate type for the system and fluid? Are the pumps fixed or variable speed?

_____

_____

h) Do the pumps operate continuously or intermittently? If intermittent, what controls the pumping cycle and how long are the pumps on and then off?

_____

_____

5) Performance Analysis Calculations

a) Are the flow rates and discharge heads currently required for effective remediation the same as those in the design specifications? Check the manufacturer's design information to see if the selected pump casing and impeller are still appropriate for the application.

_____

b) Calculate the fluid velocities in each pipe. Are they within the normal design range? *(Typically liquid velocity should not be less than approximately 2 ft/sec to minimize sedimentation and not more than approximately 8 ft/sec to minimize wear on the pipe.)*

_____

_____

6) Adequacy of Operations and Maintenance

a) Verify that all ancillary equipment are maintained per manufacturers recommendations.

_____

_____

b) Is the piping clearly labeled and are all valves tagged?

_____

_____

c) Is the piping adequately supported? Are the hangers and supports in good condition?

_____

_____

d) Is the piping alignment, location, and spacing appropriate?

_____

_____

e) Is the pipeline insulation in good condition, and is the heat tracing (if used) functioning properly?

_____

_____

f) Is the corrosion prevention system (e.g., protective coating, isolation joints, cathodic protection) in good condition? Have cathodic protection systems been inspected or tested recently by a corrosion engineer? (If applicable)

_____

_____

g) Are valves, valve operators, drivers, and controllers inspected and maintained as recommended in the operation and maintenance manual?

_____

_____

h) Are the sample ports, valves, and drains in good condition?

_____

i) Are metering systems inspected and maintained as recommended in the operation and maintenance manual?

_____
_____

j) Are there any reports of water hammer problems?

_____
_____

k) Are there physical signs of pump leakage at shaft seals or packing?

_____
_____

l) Do any pumps show signs of excessive vibration? Are all pump anchor bolts in good condition?

_____
_____

m) Are any pumps throttled down to nearly shut-off to achieve the required flow rate? *(Severely throttled pumps use more power and tend to require more maintenance.)*

_____
_____

n) Is there a preventative maintenance program for pumps and are the pump maintenance records complete and up to date?

_____
_____

o) Verify that controls and alarms are working. Are there telemetric provisions to notify an operator of a problem when the unit is not being attended?

_____
_____

7) Typical Performance Problems

a) Is there evidence of change in flow rate, temperature, or pressure over time? *(These symptoms may indicate scaling or deposition of sediment in the lines.)*

_____
_____

b) Are constituent concentrations high enough to be of concern in selecting pipe or valve materials?)

_____
_____

c) Have there been any problems with cold weather freezing of pipes or valves?

_____
_____

d) Is the pumping cycle duration excessively short or approaching the ½-on-½-off sequence? *(These conditions may be detrimental to energy consumption, pump efficiency and pump longevity.)*

_____
_____

e) For submerged pump installations, does the pump have sufficient submergence?

_____
_____

f) Are any pumps reported to have excessive bearing wear and replacement frequency? *(Excessive bearing wear may indicate misalignment or eccentric flow entering the pump inlet.)*

_____
_____

8) Alternatives for Possible Cost Savings.

The contaminant compounds in the water stream and/or the contaminant concentrations may have changed sufficiently that other alternatives are more cost effective. Consider the following:

a) Determine if the pumping operation is still necessary or have the flows and concentrations decreased so that the operation can be terminated? Can the unit be easily bypassed if no longer needed?

_____
_____

b) Identify any high cost maintenance items. Are there alternatives that might reduce these high maintenance costs?

_____
_____

c) Was the pipeline material of construction satisfactory? If corrosion is a problem, consider replacing the pipe with a different material of construction.

_____

d) Has the pump performed satisfactorily? Consider modification (impeller trim, drive replacement, etc.) or replacement with a different type pump.

_____
_____

9) Supplemental Notes and Data

There are _____ pages of supplemental notes and data attached to this checklist.

_____

[1] CEGS: USACE Guidance Specifications for Construction, available at www.usace.army.mil/inet/usace-docs/
[2] TM: USACE Technical Manual, available at www.usace.army.mil/inet/usace-docs/
[3] EM: USACE Engineering Manual