insufficient care is taken to remove as much air from the system as possible. Because air is compressible, inclusion of compressed air substantially increases the risk of catastrophic consequences of pipe or plug failure during hydro-testing. There is a need for an advanced, automated, and safe hydro-testing system and method for open-ended pipe.

SUMMARY OF THE INVENTION

Embodiments~~It is an object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method requiring less time and expense than conventional hydrostatic pressure testing systems.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method that is considerably safer than conventional hydrostatic pressure testing systems.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method that is self-contained.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method that is portable.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method that is highly accurate.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method that may be monitored from a safe distance.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method that is automated.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method capable of simultaneously testing more than one section of pipe or pressure vessel.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method for pipe.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide a hydrostatic pressure testing system and method for open-ended pipe.

Embodiments~~It is a further object~~ of the present invention ~~to~~ provide an open-ended pipe testing system and method that uses external pipe end plugs.

These and other embodiment~~objects~~s and advantages are achieved by the novel hydrostatic pressure testing system and method. ~~The hydrostatic pressure testing system may include a control center for operating the hydrostatic pressure testing system, a test fluid assembly, and a~~

~~pressure-release safety assembly. The control center may include a computer control panel, a computer display screen, a computer storage device, and a computer program. The computer program may monitor, record, and control the system during hydrostatic pressure testing operations. The test fluid assembly may include a fill conduit capable of providing a test fluid to an inlet section of a vessel to be tested in response to a command generated by the computer program. The pressure-release safety assembly may include a vent conduit capable of providing a fluid communication between an outlet section of the vessel and a safety valve. The safety valve may be in fluid communication with a bleed tank for storing an outlet flow of the test fluid from the vessel. The safety valve may be capable of being actuated to relieve a fluid pressure in the vessel undergoing hydrostatic testing in response to a selective condition of the hydrostatic pressure testing system.~~

In a first aspect, there is provided a hydrostatic pressure testing system, comprising: a control center for operating said hydrostatic pressure testing system, said control center including a computer control panel, a computer display screen, a computer storage device, and a computer program functioning to monitor, record, and control said hydrostatic pressure testing system during hydrostatic pressure testing operations; a test fluid assembly including a fill conduit, said fill conduit capable of providing a test fluid to an inlet section of a pipe to be tested in response to a command generated by said computer program; a hydrostatic-pressure seal assembly capable of sealing said pipe so that a predetermined hydrostatic pressure may be applied and held in an internal section of said pipe during said hydrostatic pressure testing operations for a predetermined length of time; and a pressure-release safety assembly including a vent conduit capable of providing a fluid communication between an outlet section of said pipe and a safety valve, said safety valve in fluid communication with a bleed tank for storing an outlet flow of said test fluid from said pipe, said safety valve capable of being actuated to relieve the hydrostatic pressure in said pipe undergoing hydrostatic pressure testing in response to a selective condition of said hydrostatic pressure testing system.

The hydrostatic pressure testing system may also include a power generation assembly capable of generating power to operate the pressure testing system. The power generation assembly may include a generator.

The test fluid assembly may also include a test fluid tank for storing the test fluid and a fill pump in fluid communication with the test fluid tank. The fill pump may be capable of pumping the test fluid from the test fluid tank through the fill conduit to the inlet section of the pipe~~vessel~~. The test fluid assembly may also include a filter in fluid communication with the test fluid tank. The filter may be capable of filtering the test fluid to remove impurities. The test fluid may be water or water and one or more additives.

The vessel may be a pipe, and the hydrostatic pressure testing system may further include a hydrostatic-pressure seal assembly capable of sealing the pipe so that a predetermined hydrostatic pressure may be applied and held in an internal section of the pipe during the hydrostatic pressure testing operations. The hydrostatic-pressure seal assembly may include a pair of seal means. The seal means may each include an internal pipe locking means or an external pipe locking means to secure the seal means to the pipe. The seal means may each be a mechanical seal, a pneumatically-actuated seal, or a hydraulically-actuated seal.

If the pipe is open-ended, the inlet and outlet sections of the pipe are inlet and outlet ends. In this embodiment, each seal means may be a hydraulically-actuated pipe end plug. One of the pipe end plugs may seal the inlet end of the pipe and the other pipe end plug may seal the outlet end of the pipe.

If each seal means is hydraulically-actuated, the pressure testing system may also include a hydraulic assembly capable of supplying a hydraulic fluid to actuate the hydraulically-actuated seal. The hydraulic assembly may include a hydraulic fluid reservoir,

a hydraulic fluid pump in fluid communication with the hydraulic fluid reservoir, and a hydraulic fluid conduit providing fluid communication between the hydraulic fluid pump and the hydraulically-actuated seals to actuate the seals.

The hydrostatic pressure testing system may further include a fluid pumping assembly capable of increasing the hydrostaticfluid pressure within an internal section of the pipevessel during hydrostatic pressure testing operations. The fluid pumping assembly may include a first pump and a second pump each in fluid communication with the internal section of the pipevessel.

The hydrostatic pressure testing system may further include a test fluid evacuation assembly capable of evacuating the test fluid from the internal section of the pipevessel after hydrostatic pressure testing operations. The test fluid evacuation assembly may include an evacuation pump in fluid communication with the internal section of the pipevessel. The evacuation pump may be capable of pumping the test fluid remaining in the internal section of the pipevessel after hydrostatic pressure testing operations.

The safety valve may be a mechanical valve, a pneumatically-actuated valve, a hydraulically-actuated valve, or an electronically-actuated valve. If the safety valve is a pneumatically-actuated valve, the pressure-release safety assembly may further include a safety-valve pneumatic compressor.

The hydrostatic pressure testing system may include a video surveillance assembly including one or more video cameras, a video image display screen capable of displaying an image captured by each of the video cameras, and a video storage device for storing the images. The video display screen and video storage device may be housed in the control center. The video surveillance assembly may be capable of being controlled and monitored remotely.

The hydrostatic pressure testing system may further include a plurality of pressure sensors capable of detecting the hydrostaticfluid pressure in the internal section of the pipevessel during hydrostatic pressure testing operations. The computer display screen may be capable of displaying the detected hydrostaticfluid pressure. The computer storage device may be capable of storing the detected fluid hydrostaticpressure. The computer program may be capable of determining whether any gas is held in the internal section of the pipevessel based on the detected hydrostaticfluid pressure and a detected volume of test fluid displaced by the fill pump.

The hydrostatic pressure testing system may further include a plurality of temperature sensors capable of detecting an internal temperature in the internal section of the pipevessel and an external temperature surrounding an outer surface of the pipevessel during hydrostatic pressure testing operations. The computer display screen may be capable of displaying the detected

temperatures. The computer storage device may be capable of storing the detected temperatures.

The hydrostatic pressure testing system may include a control module, a fluids module, a flow module, a pump module, and a power module. The control center may be disposed on the control module. The test fluid assembly may be disposed on the fluids module. The pressure-release safety assembly may be disposed on the flow module. The pump module may hold a fluid pumping assembly capable of increasing the hydrostaticfluid pressure within an internal section of the pipevessel during hydrostatic pressure testing operations. The power module may hold a power generation assembly for generating power to operate the hydrostatic pressure testing system.

In another embodiment, the hydrostatic pressure testing system may include a command module, a hydrostatic pressure seal assembly, and a secondary module operatively associated with the command module. The command module may include a control center for operating the hydrostatic pressure testing system, a test fluid assembly, a power generation assembly, a fluid pumping assembly, and a test fluid evacuation assembly. The control center may include a computer control panel, a computer display screen, a computer storage device, and a computer program. The computer program may function to monitor, record, and control the pressure testing system during hydrostatic pressure testing operations. The test fluid assembly may include a fill conduit capable of providing a test fluid to an inlet section of a pipe to be tested in response to a command generated by the computer program. The power generation assembly may be capable of generating power to operate the pressure testing system. The fluid pumping assembly may be capable of increasing the fluid pressure in an internal section of the pipe during the hydrostatic testing operations. The test fluid evacuation assembly may be capable of evacuating the test fluid from the internal section of the pipe after the hydrostatic pressure testing operations.

The hydrostatic pressure seal assembly may be capable of sealing the pipe so that a predetermined hydrostatic pressure may be applied to the internal section of the pipe during the hydrostatic pressure testing operations. The hydrostatic pressure seal assembly may be controlled by the computer program.

The secondary module may include a pressure release safety assembly including a vent conduit capable of providing a fluid communication between an outlet section of the pipe and a safety valve. The safety valve may be in fluid communication with a bleed tank for storing an outlet flow of the test fluid from the pipe. The safety valve may be capable of being actuated to relieve a fluid pressure in the internal section of the pipe during the

~~hydrostatic-pressure-testing-operations-in-response-to-a-selective-condition-of-the-pressure-testing system.~~

In a second aspect, there is provided a hydrostatic pressure testing system, comprising: a command module comprising: a control center for operating said hydrostatic pressure testing system, said control center including a computer control panel, a computer display screen, a computer storage device, and a computer program functioning to monitor, record, and control said hydrostatic pressure testing system during hydrostatic pressure testing operations; a test fluid assembly including a fill conduit, said fill conduit capable of providing a test fluid to an inlet section of a pipe to be tested in response to a command generated by said computer program; a power generation assembly capable of generating power to operate said hydrostatic pressure testing system; a fluid pumping assembly capable of increasing the fluid pressure in an internal section of said pipe during said hydrostatic pressure testing operations; a test fluid evacuation assembly capable of evacuating said test fluid from said internal section of said pipe after said pipe has undergone said hydrostatic pressure testing operations; a hydrostatic-pressure seal assembly capable of sealing said pipe so that a predetermined hydrostatic pressure may be applied and held in said internal section of said pipe during said hydrostatic pressure testing operations for a predetermined time, said hydrostatic-pressure seal assembly being controlled by said computer program; a secondary module operatively associated with said command module, said secondary module including a pressure-release safety assembly including a vent conduit capable of providing a fluid communication between an outlet section of said pipe and a safety valve, said safety valve in fluid communication with a bleed tank for storing an outlet flow of said test fluid from said pipe, said safety valve capable of being actuated to relieve a fluid pressure in said internal section of said pipe during said hydrostatic pressure testing operations in response to a selective condition of said hydrostatic pressure testing system.

The power generation assembly may include a generator.

The test fluid assembly may also include a test fluid tank for storing the test fluid and a fill pump in fluid communication with the test fluid tank. The fill pump may be capable of pumping the test fluid from the test fluid tank through the fill conduit to the inlet section of the pipe. The test fluid assembly may further include a filter in fluid communication with the test fluid tank. The filter may be capable of filtering the test fluid to remove impurities.

The hydrostatic-pressure seal assembly may include a pair of seal means. The seal means may each include an internal pipe locking means or an external pipe locking means to secure the seal means to the pipe. Each of the seal means may be a mechanical seal, a pneumatically-actuated seal, or a hydraulically-actuated seal.

If the pipe is open-ended, the inlet and outlet sections of the pipe are inlet and outlet ends. In this embodiment, each seal means may be a hydraulically-actuated pipe end plug. One of the pipe end plugs may seal the inlet end of the pipe and the other pipe end plug may seal the outlet end of the pipe.

If each seal means is a hydraulically-actuated seal, the pressure testing system may also include a hydraulic assembly capable of supplying a hydraulic fluid to actuate the hydraulically-actuated seal. The hydraulic assembly may include a hydraulic fluid reservoir, a hydraulic fluid pump in fluid communication with the hydraulic fluid reservoir, and a hydraulic fluid conduit providing fluid communication between the hydraulic fluid pump and the hydraulically-actuated seals to actuate the seals.

The fluid pumping assembly may include two or more pumps in fluid communication with the internal section of the pipe. The test fluid evacuation assembly may include an evacuation pump in fluid communication with the internal section of the pipe. The evacuation pump may be capable of pumping test fluid remaining in the internal section of the pipe after hydrostatic pressure testing operations. The safety valve may be a pneumatically-actuated valve, and the pressure-release safety assembly may also include a pneumatic compressor.

The hydrostatic pressure testing system may include a video surveillance assembly including one or more video cameras, a video image display screen capable of displaying an image captured by each of the video cameras, and a video storage device for storing the images. The video display screen and video storage device may be housed in the control center.

The hydrostatic pressure testing system may further include a plurality of pressure sensors capable of detecting the fluid pressure in the internal section of the pipe during hydrostatic pressure testing operations. The computer display screen may be capable of displaying the detected fluid pressure. The computer storage device may be capable of storing the detected fluid pressure. The computer program may be capable of determining whether any gas is held in the internal section of the pipe based on the detected fluid pressure and a detected volume of the test fluid pumped by the fill pump.

The hydrostatic pressure testing system may further include a plurality of temperature sensors capable of detecting an internal temperature in the internal section of the pipe and an external temperature surrounding an outer surface of the pipe during hydrostatic pressure testing operations. The computer display screen may be capable of displaying the detected temperatures. The computer storage device may be capable of storing the detected temperatures.

The command module and the secondary module may each be self-contained and adapted for mobility. The system may be capable of conducting simultaneous hydrostatic pressure testing operations on a plurality of pipes. The test fluid assembly may include one or more additional fill conduits. Each fill conduit may be capable of providing the test fluid to an inlet section of one of the pipes. The pressure-release safety assembly may include one or more additional vent conduits and one or more additional safety valves. Each vent conduit may be capable of providing a fluid communication between the outlet section of one of the pipes and one of the safety valves.

The selective condition may be a failure of the power generating assembly, a detection of a leak in the hydrostatic-pressure seal assembly, a detection of a movement of the hydrostatic-pressure seal assembly and an activation of one of a plurality of manual override switches provided on the pressure testing system. One or more manual override switches may be located at an external location on the command module. One or more manual override switches may be located within the control center. One or more manual override switches may be located at an external location on the secondary module.

~~A method of hydrostatic pressure testing may include providing a hydrostatic pressure testing system. The pressure testing system may include a command module having a control center for operating the system, a test fluid assembly, a power generation assembly capable of generating power to operate the pressure testing system, a fluid pumping assembly, a test fluid evacuation assembly, and a secondary module operatively associated with the command module. The control center may include a computer control panel, a computer display~~

~~screen, a computer storage device, and a computer program. The computer program may monitor, record, and control the system during hydrostatic pressure testing operations. The test fluid assembly may include a fill conduit capable of providing a test fluid to an inlet section of a vessel to be tested in response to a command generated by the computer program. The fluid pumping assembly may be capable of increasing the fluid pressure in an internal section of the vessel during the hydrostatic pressure testing operations. The test fluid evacuation assembly may be capable of evacuating the test fluid from the internal section to the vessel after hydrostatic pressure testing operations. The secondary module may include a pressure-release safety assembly having a vent conduit capable of providing a fluid communication between an outlet section of the vessel and a safety valve. The safety valve may be in fluid communication with a bleed tank for storing an outlet flow of the test fluid from the vessel. The safety valve may be capable of being actuated to relieve a fluid pressure in the internal section of the vessel during the hydrostatic pressure testing operations in response to a selective condition of the pressure testing system.~~

~~The method of hydrostatic pressure testing may also include filling the internal section of the vessel with the test fluid. A predetermined fluid pressure may be applied to the internal section of the vessel. The fluid pressure in the internal section of the vessel may be monitored, recorded, and evaluated to determine if the fluid pressure has been maintained in a specified range for a prescribed time period.~~

In a third aspect, there is provided a method of hydrostatic pressure testing, comprising the steps of:

a) providing a hydrostatic pressure testing system comprising: a command module comprising: a control center for operating said hydrostatic pressure testing system, said control center including a computer control panel, a computer display screen, a computer storage device, and a computer program functioning to monitor, record, and control said hydrostatic pressure testing system during hydrostatic pressure testing operations; a test fluid assembly including a fill conduit, said fill conduit capable of providing a test fluid to an inlet section of a vessel to be tested in response to a command generated by said computer program; a power generation assembly capable of generating power to operate said hydrostatic pressure testing system; a fluid pumping assembly capable of increasing the fluid pressure in an internal section of said vessel during said hydrostatic pressure testing operations; a test fluid evacuation assembly capable of evacuating said test fluid from said internal section of said vessel after said vessel has undergone said hydrostatic pressure testing operations; a secondary module operatively associated with said command module, said secondary module including a pressure-release safety assembly including a vent conduit capable of providing a fluid communication between an outlet section of said vessel and a safety valve, said safety valve in

fluid communication with a bleed tank for storing an outlet flow of said test fluid from said vessel, said safety valve capable of being actuated to relieve a fluid pressure in said internal section of said vessel during said hydrostatic pressure testing operations in response to a selective condition of said hydrostatic pressure testing system; a pressure sensor disposed in said internal section of said vessel which is operatively controlled by said computer program, said pressure sensor detecting said fluid pressure in said internal section of said vessel; an internal temperature sensor in said internal section of said vessel which is operatively controlled by said computer program, said internal temperature sensor detecting an internal temperature in said internal section of said vessel; an external temperature sensor external to said vessel which is operatively controlled by said computer program, said external temperature sensor detecting an external temperature at an outer surface of said vessel;

b) filling said internal section of said vessel with said test fluid;

c) applying a predetermined fluid pressure to said internal section of said vessel;

d) monitoring said fluid pressure in said internal section of said vessel;

e) recording said fluid pressure in said internal section of said vessel;

f) evaluating said fluid pressure in said internal section of said vessel to determine if said fluid pressure has been maintained in a specified range for a prescribed period of time;

g) monitoring said internal and external temperatures;

h) recording said internal and external temperatures;

i) evaluating said internal and external temperatures to determine if said temperatures influenced said fluid pressure monitored in said internal section of said vessel.

The vessel of the hydrostatic pressure testing system may be a pipe. The hydrostatic pressure testing system may further include a hydrostatic-pressure seal assembly. The hydrostatic-pressure seal assembly may be capable of sealing the pipe so that a predetermined hydrostatic pressure may be applied to the internal section of the pipe during the hydrostatic pressure testing operations. The hydrostatic-pressure seal assembly may be controlled by the computer program. The method of hydrostatic pressure testing may also include sealing the pipe~~vessel~~ by operatively connecting the hydrostatic seal assembly to the pipe~~vessel~~.

The hydrostatic pressure testing system may also include a pressure sensor in the internal section of the vessel which is operatively controlled by the computer program. The pressure sensor may detect the fluid pressure in the internal section of the vessel. The system may also include an internal temperature sensor in an internal section of the vessel which is operatively controlled by the computer program. The internal temperature sensor may detect an internal temperature in the internal section of the vessel. The system may also include an external temperature sensor outside of the vessel that is operatively controlled by the computer program. The external temperature sensor may detect an external temperature at an

outer surface of the vessel. The method may also include monitoring, recording, and evaluating the internal and external temperatures to determine if the temperatures influenced the fluid pressure monitored in the internal section of the vessel.

The method may also include using the computer program to determine whether any gas remains in the internal section of the vessel based on the detected fluid pressure and a detected volume of test fluid pumped by the fluid pumping assembly.

The method may further include evacuating the test fluid remaining in the internal section of the vessel after hydrostatic pressure testing operations and removing the hydrostatic-pressure assembly from the vessel. ~~The method may be simultaneously performed on a plurality of vessels.~~

In a fourth aspect, there is provided a method of hydrostatic pressure testing, comprising the steps of:

a) providing a hydrostatic pressure testing system comprising: a command module comprising: a control center for operating said hydrostatic pressure testing system, said control center including a computer control panel, a computer display screen, a computer storage device, and a computer program functioning to monitor, record, and control said hydrostatic pressure testing system during hydrostatic pressure testing operations; a test fluid assembly including a fill conduit, said fill conduit capable of providing a test fluid to an inlet section of a vessel to be tested in response to a command generated by said computer program; a power generation assembly capable of generating power to operate said hydrostatic pressure testing system; a fluid pumping assembly capable of increasing the fluid pressure in an internal section of said vessel during said hydrostatic pressure testing operations; a test fluid evacuation assembly capable of evacuating said test fluid from said internal section of said vessel after said vessel has undergone said hydrostatic pressure testing operations; a secondary module operatively associated with said command module, said secondary module including a pressure-release safety assembly including a vent conduit capable of providing a fluid communication between an outlet section of said vessel and a safety valve, said safety valve in fluid communication with a bleed tank for storing an outlet flow of said test fluid from said vessel, said safety valve capable of being actuated to relieve a fluid pressure in said internal section of said vessel during said hydrostatic pressure testing operations in response to a selective condition of said hydrostatic pressure testing system;

b) filling said internal section of said vessel with said test fluid;

c) applying a predetermined fluid pressure to said internal section of said vessel;

d) monitoring said fluid pressure in said internal section of said vessel;

e) recording said fluid pressure in said internal section of said vessel;

f) evaluating said fluid pressure in said internal section of said vessel to determine if said fluid pressure has been maintained in a specified range for a prescribed period of time;

wherein steps (b) through (f) are simultaneously performed on a plurality of vessels.

The hydrostatic pressure testing system as per embodiments of the present invention is self-contained. The system of an embodiment is also computerized. Features of the system include:

(1) capable of hydro-testing 2" through 30" diameter open-ended pipe;

(2) 2" through 12" to 5,000 psi and 14" through 30" to 3,000 psi;

(3) hydraulically-actuated external pipe plugs are installed and removed in minutes;

(4) capable of testing three pipes of the same or different size simultaneously;

(5) automated system with advanced and unique safety systems;

(6) economical, safe, fast and accurate hydro-testing;

(7) test pressure range capability covers all pipe grades and weights as well as alloys, stainless and other exotic materials;

(8) safe to use with all internal pipe coatings;

(9) highly mobile, self-contained system;

(10) web enabled remote monitoring of hydrostatic pressure testing operations with the video surveillance system; and

(11) web enabled remote monitoring of the pressure and temperature with the computer systems.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of the hydrostatic pressure testing system of the present invention for testing pipe.

FIG. 2 is a schematic illustration of the command unit of the hydrostatic pressure testing system for testing pipe.