Specification for electric valve actuator remote control system

General

The data monitoring and control system shall consist of a *Master Station* and field units. The *Master Station* shall perform the tasks of bus master, data collector, data concentrator, operator interface, protocol converter and be a slave to a host system.

The system shall be capable of operating with up to 60, 120, 180 or 240 field units on a 2 wire screened twisted pair data highway or twisted pair plus common data highway.

The 2-wire network should be capable of operating over long lengths up to at least 20 kilometres (12.5 miles) without externally fitted repeaters or other additional devices. The cable shall be connected from the *Master Station* to each field unit in turn and back to the *Master Station* in a loop formation.

The *Master Station* shall provide data communication with a host system such as a DCS and PLC via data ports using either Modbus TCP or Modbus RTU protocol.

Master Station

The *Master Station* shall be of microprocessor type, suitable either for panel or 19" rack mounting.

It shall be suitable for the following operational conditions:

Operating temperature: -10°C to +50°C (+14°F to +122°F)
Storage temperature: -10°C to +70°C (+14°F to +158°F)
Relative Humidity: 5% to 95% non-condensing
Power: 100-240 V (+/- 10%) 50 / 60 Hz

The *Master Station* shall include a colour touch screen interface to allow it to be used as a local operator interface, in addition a built-in web server should allow *Master Station* web pages to be displayed using a standard browser via an Ethernet connection. No special software of license should be necessary for accessing the data in the *Master Station* or for configuration of the *Master Station*. It shall be possible to fully configure the *Master Station* and associated option modules via the touch screen interface or web interface.

The user interface shown on the web pages should mirror the local display for consistency of operation and should allow for standalone operation when the host system is not present.

The user interface shall be multi-lingual.

The user interface shall be capable of showing the status and Tag number of every connected field device, the status of the *Master Station*, the system settings, the host protocol messages, the field network performance, any alarms present on the system and the status of any hot standby partner.

The user interface shall permit viewing and (where authorised) modification of all of the *Master Station* system data. It shall also allow the connected devices to be monitored and (where authorised) operated. Parameters set in each field device shall be visible and (where authorised) there shall be a mechanism for altering field device settings.

A security system shall be included to prevent access to control and setting of parameters via the *Master Station* user interface. Control shall be able to be interlocked by inhibiting actuator commands from any host port. The ability to allow only limited host IP addresses to access the *Master Station* via Modbus TCP will also be provided.

A real time clock shall be included for alarm event time/date marking and it shall be possible to

synchronise this clock via an NTP (Network Time Protocol) server.

It shall be possible to capture and display on the user interface the last 5 messages sent to the *Master Station* and the replies from the *Master Station*, via the host communications ports. It shall be possible to view the loop status including a map of the connected field devices and their communications status.

It shall be possible to capture and display on the user interface the last 5 alarms present on the *Master Station* or the field units. The alarms should be able to be cleared on the user interface separately to the Modbus host database alarms.

The *Master Station* shall have internal logs of host communications for viewing real time communications and for historic logging of commands to the *Master Station* from the host for. Logs and alarms should have a facility for e-mail notification and file transfer.

The *Master Station* shall continuously check; itself, the connected field networks and field devices for alarms, and alert the local operators to the exact nature of a problem, if one occurs.

Master Station shall have a fixed data base, once a DCS has been configured with one *Master Station*'s database, this can simply be copied and pasted multiple times for all other *Master Station*s on the site.

Industry standard Namur NE107 diagnostics indication coding of field device status on HMI and web pages shall be used for instant identification of any fault and its severity.

It should be possible to run multiple field networks on one *Master Station*. There should be a choice of different types of field networks.

All option modules should be "hot swappable" to avoid no system disruption on module addition.

The *Master Station* should support the easy integration of 3rd party devices (other manufacturer's products) into the *Master Station* database.

Where the field network capabilities allow, it shall be possible to extract historical logs from field devices and to save them to a local PC via the web interface.

Host Communications

Host system communication shall be by Ethernet, primarily and optionally via serial (RS232, RS485).

The host protocol shall be Modbus (TCP or RTU) to minimise custom software and programming.

There will be 2 Ethernet host ports available as standard and an additional third Ethernet port (Configuration port), available as standard, to be used for configuration, service and other temporary connections. Serial host communications will be available with the option to add a further 2 serial ports, selectable as either RS232 or RS485.

The Ethernet communications baud rate shall be 1GB, 100MB or 10MB on all three ports. The Baud rate for serial communications shall be adjustable from 2400 to 115200 with odd, even, always zero or no parity.

The dedicated configuration port shall be such that there is physical and logical separation between configuration (and monitoring systems) and systems for controlling the process.

The Ethernet connection will include a web server and embedded web pages shall provide the ability to parameterise, control and monitor the connected actuators. The Ethernet connection shall support at least 10 simultaneous users.

All communications ports shall be independent to ensure correct alarm handling to each of the connected hosts, or for use in redundant host communications.

All Ethernet ports (host and configuration) shall have the same Ethernet services.

Redundant Systems - Hot Standby

When required the *Master Station* shall include a redundant 'hot standby' unit that will automatically assume control if the primary unit fails, this transfer of control shall be user transparent, seamless and take less than 2 seconds. The status of the standby and primary units shall be available for review by the host system at all times. It shall be possible to change control from primary to standby unit either remotely (over the communication link) or locally at the *Master Station*.

All *Master Station* interfaces shall be replicated in the back up, to ensure that there is no 'single card' failure mode

Open Field Communications – Modbus RTU

The network options shall be versatile and allow for a Modbus RTU redundant loop configuration or a redundant dual channel highway or a non-redundant single highway. All signals from the *Master Station* to the field units shall be suitable for transmission over a standard data comms twisted pair cable with a common and overall screen. In redundant loop mode the cable shall be connected from the *Master Station* to each field unit in turn and then back to the *Master Station*.

The speed of communications over the network will be a minimum of 9.6 kbps, up to a maximum of 115.2 kbps.

The maximum distance between devices (a segment) shall be up to 1.2 km, without the need for additional external repeaters or terminators. Network speed shall be the same baud rate for each segment.

The system shall cyclically poll each connected field unit and report the status of the field unit or communication failure. On receipt of a command from the *Master Station* user interface or the host system, such as a PLC, the command shall take precedence over the data collection, polling shall cease and the command shall be immediately transferred to the field unit. Provision to ensure the field unit has received the command correctly is included in the Modbus open protocol.

When used in a loop arrangement, failure or loss of power to any one or more connected field units on the highway shall not cause loss of control or communication with the remaining devices connected to the cable. On restoration of power to a field unit it shall be communicated with automatically.

The system shall tolerate a single open, short or ground fault in the highway, when connected as a loop or dual highway redundant system, without losing the ability to communicate and control any field unit remaining connected. In loop operation an alarm shall be posted to indicate between which two field units the fault has occurred. Multiple faults could result in the loss of communication with those field units which have become isolated but not in loss of communications to the entire system.

It shall be possible to connect up to 240 devices on one highway.

It shall be possible to allow 3rd party devices onto the network.

It should be possible to extract historical torque information from capable field devices through the network.

Field units shall be plug in cards, or easily added to existing valve actuators.

Network Parameter Settings – Modbus RTU

There shall only be a requirement to configure a unique address (up to 240) for each field unit along with a common baud rate and parity setting. No other field network parameters will be required to be set. The address setting shall be made non-intrusively either using a hand held tool or via the Modbus highway, without the need to remove covers or gain access directly to the field unit itself.

Field Communications – Current Loop Network

The 2 wire loop shall use a 20 mA current for data transmission with a maximum applied voltage of 17V. The current shall be modulated to enable messages to be transmitted. Full CRC and message framing checks must be included in the data protocol.

The system shall continuously cyclically poll each connected field unit and report any changes in status of the field unit or communication failure. On receipt of a command from the *Master Station* user interface or the host system such as a PLC the command shall take precedence over the data collection, polling shall cease and the command shall be immediately transferred to the field unit. Provision shall be included to ensure the field unit has received the command correctly.

Failure or loss of power to any one or more connected field units on the 2 wire cable shall not cause loss of control or communication with the remaining devices connected to the cable. On restoration of power to a field unit it shall be located and communicated with automatically.

The system shall tolerate a single open, short or ground fault in the 2 wire cable without losing the ability to communicate and control any field unit remaining connected. An alarm shall be posted to indicate between which two field units the fault has occurred. Multiple faults shall result in the loss of communication with those field units which have become isolated and not the entire system. This cable security feature shall be inherent in the system and achieved using only a single cable without the need for duplicate or additional hardware.

All signals from the *Master Station* to the field units shall be suitable for transmission over a 2 wire twisted pair cable with overall screen and shall use a current loop serial data communication and shall be noise tolerant. This cable shall be connected from the *Master Station* to each field unit in turn and then back to the *Master Station*.

Loop shall be capable of adding simple on/off control and position feedback of third party devices including third party actuator brands, by using vendor's actuator as a network hub, or through use of a standalone field control unit.

The facility to test system performance and adjust the field communication speed shall be provided.

It shall be possible to set the highest address number of connected field units to minimise scanning times.

Field units shall be plug in cards, or easily added to existing valve actuators. They shall also be available in a variety of enclosures suitable for location in the field or control room environment.

The *Master Station* network interface and field units shall be protected against lightning by the provision of transient suppressor devices on all 2 wire connection ports rated at 1.5 kV for 1 millisecond. Opto-isolation shall be used within the field units and *Master Station* network interface for enhanced noise protection.

Network Parameter Settings – Classic Network

There shall be settings for the loop baud rate and unique address (up to 240) for each field unit. These settings shall be made non-intrusively either using a hand held tool or via the highway, without the need to remove covers or gain access directly to the field unit itself. the need to remove covers or gain access directly to the field unit itself. Where general purpose field units are required it shall be possible to invert the reported input signal status.

Valve Actuator Field Units

When fitted to a suitable valve actuator the field unit shall require no additional power connection. The field unit shall form an integral part of the actuator assembly and it shall be an addition to the actuator control circuit and independent from that control circuit. It shall report the following signals to the *Master Station* as a minimum:

Valve opening, Valve closing, Valve open, Valve closed, Valve stationary in mid position, Actuator fault, Field unit fault.

In addition it shall also report some or all of the following signals:

Continuous valve position
Monitor relay trip
Thermostat trip
Local Stop selected
Local Control selected
Valve Obstructed
Valve Jammed
Four additional remote digital input signals, using the actuator as a hub.
One remote analogue input signal, using the actuator as a hub.

Remote control functions shall be provided to permit the actuator to perform some or all of the following commands, dependent upon the actuator type:

Open fully
Close fully
Stop at any time
Assume an intermediate position
Assume Emergency Shut Down position
Perform a partial stroke

Receipt of an ESD signal shall override any existing, local or remote, open or close signal. An additional hard-wired ESD facility shall still remain within the actuator control capability.

When forming an integral part of the actuator the field unit shall ideally be located in a separate compartment from the field terminals. This compartment shall ideally be sealed from the external environment. The whole enclosure shall be to IP68 (NEMA IV and NEMA VI). In hazardous area applications it shall be certified to a minimum of EExd IIB T4, or to the same certification as the actuator.

The actuator and field unit combination shall be suitable for an ambient operating temperature range of -30°C to +70°C (-22°F to +158°F) and storage temperature range -30°C to +80°C (-22°F to +176°F).

General Purpose Field Unit – CLASSIC NETWORK

General Purpose field units shall be similar to actuator field units with the same isolation and protection capabilities. They shall be capable of reporting the status of 8 digital and 2 analogue (for example 4-20 mA) inputs.

The field unit shall be capable of providing 4 digital outputs, each configurable for fleeting or maintained status and 1 analogue (0-5V) output. All I/O shall have discrete address capability.

When field mounted, the field unit enclosure shall be to IP68 (NEMA IV and NEMA VI). In hazardous area applications it shall be certified to a minimum of EExd IIB T4. The field unit must be located in a separate 'O' ring sealed compartment from the field terminals to preclude the ingress of moisture.

For control room location the field unit shall be 19 inch rack mounting and provided with a suitable 19 inch rack. All connections to the unit shall be to the front.

The General Purpose field unit shall be suitable for an ambient operating temperature range -30°C to +70°C (-22°F to +158°F) and storage temperature range -30°C to +80°C (-22°F to +176°F).

TEST EQUIPMENT – CLASSIC NETWORK

Hand held test equipment shall be provided to facilitate the testing of installed field units and the setting of field unit parameters. Field unit testers shall be able to emulate *Master Station* communication on the 2 wire loop terminals as well as evaluate status and diagnostic information.