**SCOPE OF WORK - SAMPLE**

After building a business case for an upgrade, it is necessary to obtain an overall cost for the project. Therefore, you need to create a scope of work that establishes standards for vendors to quote. Below is a sample Scope of Work that can be downloaded from our website at <http://www.integratedcontroltech.com/>

**COMPANY NAME**

**CONTROL UPGRADE FOR EXTRUSION LINE 1**

**By (Project Manager’s Name)**

**Company Address**

**City, State, ZIP**

**Email:**

**OVERVIEW**

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| **I** | **The following is a scope of work for an extrusion line control upgrade. It is to be used as a means of creating a quotation for the project in accordance with the specifications put forth in this document.** |

To be considered as a vendor for this project, a company must be recognized within the extrusion industry as one that specializes in the after-market upgrades of extruders. The recognition comes from multiple user references within the industry, membership in Plastics Industry Association, published articles within industry magazines and participation in industry tradeshows and conferences. In addition, the company should be a UL508a panel shop with four or more electrical engineers on staff. A company resume’ must be included with this quotation affirming all the requirements as listed.

**THE OBJECTIVE**

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| **II** | **Extrusion Line 1 is a line manufactured by (Davis-Standard, Welex, etc.,) that utilizes an obsolete control system or does not meet our company’s current safety and automation goals. The proposed system will meet the following needs:** |

1. Need #1: Improved Diagnostics with the following specifications:
	1. Shorted Solid-State Relay Indication
	2. High Pressure Warning
	3. Open Heater Indication
	4. Cabinet Temperature Warning
	5. Audible and Visible Alarms
2. Need #2: Improved Protection with the following specifications:
	1. Runaway Heat Protection (Contactor or Shunt-trip Breaker)
	2. High Pressure Shutoff
	3. Cold-Zone Inhibit
	4. Arc-Flash or Arc-Flash Plus (Low Voltage Power Allowed for Diagnostics)
3. Need #3: Improved System Data Collection with the following specifications:
	1. Process Data Collection
	2. Alarm Log (Date and Time Stamped with Description)
	3. Maintenance Log
	4. Machine Operation Efficiency
4. Need #4: Improved Features
	1. Recipe Storage
	2. Recipe Scheduling
	3. Soak Feature
	4. Animated Graphics for Ease of Use
	5. Trending
	6. Preventive Maintenance Scheduling
5. Need #5: System Accessibility
	1. User Defined Log-in’s and Security
	2. Remote Factory Support
	3. Remote Screen Access
6. Need #6: Improved Documentation
	1. System User Manual
	2. Authorized Program Access with Non-Disclosure Agreement
	3. Wiring Diagram with Wire Numbers to identify specific location on drawings

**PROGRAMMABLE LOGIC CONTROLLER (PLC) & HUMAN MACHINE INTERFACE (HMI)**

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| **III** | **A PLC and an HMI will be used for extruder control with software that uses ladder logic as a means of control. A computer will not be used as a means of control and would be accepted as part of the system if it were used for data collection and storage only. The PLC and HMI will have the following specifications:** |

1. The HMI will be a color touch-screen with a screen diagonal of 15 inches or more
2. The PLC will have Modbus TCP/IP communication and Ethernet IP
3. The PLC will either be a PLC/PC combination such as the:
	1. Siemens ET200SP Open Controller
	2. Unitronics UniStream OPLC
	3. a standard PLC such as the Rockwell Contrologix which allows a separate computer for data collection.
4. The PLC and HMI are to be industrial rated able to withstand temperatures of 55oC or 131oF
5. The PLC will consist of at least 1 MB of ladder memory capable of supporting over 2000 I/O

**HEATER SAFETY**

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| **IV** | **The heater safety system shall detect and control the following:** |

1. Heater thermocouple signal loss
2. Low and High Temperature Warnings
3. Shorted Solid-State Relay Detection
4. Open Heater Detection
5. Run-Away Heater Detection and Power Disconnect with Contactor or Shunt-Trip Breaker

**HEATER PANEL DESCRIPTION**

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| ***V*** | **(Give a brief description of the heat function such as) The (Davis-Standard, Welex, etc.) has a total of 12 heat zones. The barrel zones are Heat-Cool Controls and the remainder are Heat Only. The extruder is air-cooled using single phase, 120VAC fans.**  |

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| --- | --- | --- | --- | --- | --- |
| Heater # | Description | Volts/Phase | Watts | Amps | Control/Type |
| 1 | Barrel Zone 1 | 480VAC/3Ø | 20 kW | 24 A | Heat & Cool/Air |
| 2 | Barrel Zone 2 | 480VAC/3Ø | 20 kW | 24 A | Heat & Cool/Air |
| 3 | Barrel Zone 3 | 480VAC/3Ø | 20 kW | 24 A | Heat & Cool/Air |
| 4 | Barrel Zone 4 | 480VAC/3Ø | 20 kW | 24 A | Heat & Cool/Air |
| 5 | Barrel Zone 5 | 480VAC/3Ø | 20 kW | 24 A | Heat & Cool/Air |
| 6 | Screen Changer | 240VAC/1Ø | 7.5 kW | 31 A | Heat Only |
| 7 | Adapter | 240VAC/1Ø | 7.5 kW | 31 A | Heat Only |
| 8 | Die 1 | 240VAC/1Ø | 5 kW | 21 A | Heat Only |
| 9 | Die 2 | 240VAC/1Ø | 5 kW | 21 A | Heat Only |
| 10 | Die 3 | 240VAC/1Ø | 5 kW | 21 A | Heat Only |
| 11 | Die 4 | 240VAC/1Ø | 5 kW | 21 A | Heat Only |
| 12 | Die 5 | 240VAC/1Ø | 5 kW | 21 A | Heat Only |

**SOLID STATE RELAY SELECTION**

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| **VI** | **There are three methods of heater control using solid-state relays that will be accepted in this proposal and are as follows:** |

1. Intelligent Solid-State Relay (SSR) such as the Carlo Gavazzi RGC1S or Crydom Nova 22 SSRs. When using this method, the PID for temperature control is performed within the PLC and all diagnostics, such as shorted solid-state relay and open heater indication, are performed by the Intelligent SSR. There is a fault output that can be connected to the PLC for fault notification and fault determination is given by visual light indication on the SSR. More components are required to provide specific fault indication to the PLC.
2. Intelligent Temperature Control Module such as the Gefran GFX4. This module contains up to 4 single phase heater zones or 2 three phase zones. Modules are individually fused with the PID resident on the module. The PLC must use Modbus communications to control and monitor module functions.
3. Solid-State Relay with individual Current Transformers (CT). In this method, the PLC performs all PID and Diagnostics. This is the least desirable method because of program complexity especially in systems with more than 20 zones.

**MOTOR CONTROL**

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| **VII** | **The following is a listing of all motor control required for this project** |

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| Motor | Description | Volts | HP | RPM | Conduit Box/Coupled | Control Type |
| 1 | Extruder | 480VAC | 150 | 1750 | F2/ Belt Coupled | AC Vector /Open Loop |
| 2 | Primary Nip | 480VAC | 3 | 1750 | F1/Direct Coupled | AC Vector/Closed Loop |
| 3 | Air Ring Blower | 480VAC | 10 | 1750 | F1/Direct Coupled | **AC Drive - V/Hz** |
| 4 | Pump | 480VAC | 2 | N/A | N/A | Motor Starter |
| 5 | Vacuum | 480VAC | 2 | N/A | N/A | Motor Starter |

Motors are to be quoted on items 1-3. Motors existing on item 4-5.

**WIRING METHODOLOGY**

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| **VIII** | **The electrical panel will be UL or cUL rated with the following:** |

1. All Solid-State Relays are individually fused with semiconductor fuses in finger-safe fuse blocks
2. Wire Color shall be as follows:
	1. Black – 3 phase or single phase wiring over 120VAC
	2. Red – 120 VAC Control Wiring
	3. White – Current-carrying grounded conductor
	4. Blue – DC Wiring
	5. Green – Equipment Grounding
3. All wires will have (ferrule) connectors up to 14 gauge wire.
4. All wiring will be in recognized raceway such as Thomas & Betts. DC and AC wiring are to be in separate raceways.
5. All Ethernet communication cable will be certified Cat6e shielded
6. All new AC drives will use Modbus TCP/IP for control communication and monitoring. Discrete control can be used for older drives that are retained in the upgrade.

**ENCLOSURE DESIGN SPECIFICATIONS**

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| **IX** | **Free-Standing NEMA 12 enclosure painted RAL 7035 Grey River Texture High Gloss with the following design specifications:** |

1. Flange-Mounted Main Circuit Breaker
2. Door-Mounted program access port with 120 VAC socket
3. Human Machine Interface to be mounted in one or more of the following configurations
	1. Door-Mounted
	2. Swing-Arm Mounted to the Enclosure
	3. Remote Operator Station
4. Door-Mounted Keypad Operators for all AC Drives
5. Enclosure Cooling will be one of the following based upon the heat calculations
	1. Top-mounted fans with filters mounted on the lower portion of the enclosure door
	2. Side-Mounted Air Conditioner
	3. Side-Mounted Water-to-Air Heat Exchanger
6. A Thermal Sensor will be mounted inside the enclosure and alert the PLC if the temperature exceeds 400 C.
7. Die plugs are to be the Meltric DS Series switch-rated die plugs
8. A three-color tower light will be mounted to the top of the enclosure to alert operators of an alarm condition
	1. Green - All systems operating as normal
	2. Yellow – A warning condition has occurred in one of the settings
	3. Red – Fatal Alarm that will shut down the line
9. An audible alarm similar to Federal Signal # 350WB120 or as a component of the tower light
10. The enclosure will be shipped in a wooden crate (fully enclosed) and securely fastened so that it does not become loose during shipping.

## ACCEPTABLE MANUFACTURERS OF ELECTRICAL EQUIPMENT

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| **X** | **The following is a list of acceptable manufacturers for this project, no substitutions can be made without prior approval.** |

1. AC Drives
	1. Yaskawa
	2. ABB
	3. Rockwell
2. AC Motors
	1. Reliance RPMAC
	2. Reliance VS-Master
	3. Marathon BlackMax
	4. Marathon BlueMax
3. Motor Starters and Contactors
	1. Square D
	2. Siemens
	3. Rockwell
4. Solid Stater Relays
	1. Gefran GFX4
	2. Carlo Gavazzi
	3. Crydom
5. Programmable Logic Controller (PLC)
	1. Unitronics UniStream OPLC
	2. Siemens ET200SP Open Controller
	3. Rockwell ControLogix
6. Human Machine Interface
	1. Unitronics USP-156-B10 (15” Screen)
	2. Siemens 6AV7 863-4TB10-0AA0 (19” Screen)
	3. Rockwell Panelview 2715-T5CD-B

**DOCUMENTATION**

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| **XI** | **The following is a list of acceptable manufacturers for this project, no substitutions can be made without prior approval.** |

Attached are schematics of the current system with pictures of the installed panels and motors showing the configuration to the load and nameplate data. (Best Practices include a consistent pattern of picture taking and naming if covering multiple panels. All pictures should allow for complete clarity and consistency)

