1 Purpose

This specification defines the requirements for subcontracted, custom test equipment.

This specification applies only to the South Bend location.

2 Definitions

GDS	Bosch General Delivery Specifications for Machinery and Equipment Manual
RFQ	Request for Quotation
Sbd	South Bend Location

3 References

OSHA	Occupational Safety and Health Act
IOSHA	Indiana Occupational Safety and Health Act
MSDS	Material Safety Data Sheet
MSA	AIAG Measurement Systems Analysis Reference Manual
NFPA 70	National Electrical Code
NFPA 79	Electrical Standard for Industrial Machinery
GDS	Bosch General Delivery Specifications for Machinery and Equipment Manual
AC-Sbd 6-50	Indirect Materials, Purchasing, Shipping and Receiving
AC-Sbd 11-105	Control of Inspection, Measuring, And Test Equipment

4. Procedure

4.1 General

4.1.1 Building Services Available

- Electric
  - 480 Volt, 3 phase, 60 cycle ±15%
  - 120 Volt, 1 Phase, 60 cycle ±15%
- Compressed Air
  - 120psi
- Water
  - 50 PSI
- Gas
  - Natural gas provided @ 10psi per cubic foot
- Vacuum
  - 20 in. of Hg

4.2 Mechanical Design

4.2.1 Components

- Refer to Appendix “A” for a listing of preferred mechanical/ pneumatic components
- SAE hardware is used through-out the test stand, unless otherwise specified.

4.2.1.2.1 When applicable, the preferred choice for safety relays and E – Stop buttons are: Button – Square D part # 9001-TRM4-Y205, Safety Relay – STI part # SA10MD or Telemecanique – part # XPS-AT-5110. If necessary, an equivalent part may be substituted.

- Test Stand enclosures are Stainless Steel or standard frame with Stainless Steel panels.

4.3 Wire Termination and Labeling

4.3.1 Wiring methods

- The intent of this document is to insure that Bosch standards are adhered to in the wiring of new test equipment. These methods are based on the NFPA 70 & NFPA 79 standards. If a condition is not outlined or defined in this document, then the NFPA 70 or 79 should be consulted for clarification.

4.3.2 Conductor sizing:

- Conductor ampacity shall be sized appropriately as defined in NFPA 79 Sec. 16, Table 11. For example:

AWG	Raceway @ 60 Deg. C	Enclosure @ 60 Deg. C
24	2	2
22	3	3
20	5	5
18	7	7
16	10	10
14	15	20
12	20	25
10	30	40
8	40	60
6	55	80
4	70	105
3	85	120
2	95	140
1	110	165
0	125	195
2/0	145	225
3/0	165	260
4/0	195	300

See NFPA 79 Sec. 15.3

4.3.3 Conductor type:

- Conductors shall be of types MTW, THHN, THWN, or THW with the characteristics listed in NFPA 79 Sec. 15.1.1
- Multiconductor flexible power cords shall be of types SO, STO, STOW or SJO, SJOW, SJTO with the characteristics listed in NFPA 79 Sec. 15.1.1

- Jacketed multiconductor assemblies shall be composed of PVC unless frequent exposure to brake fluid is expected. In which case, Teflon jacketing and insulation should be used.
- Conductors shall conform to standards outlined in NFPA 79 Sec. 15.2
- Temperature rating
- Minimum rating should not fall below 80 deg. C. unless ambient temperature dictates higher rating.
- Voltage rating
- Minimum rating of 300 V for control wiring, 600 V for power.

4.3.4 Wire termination

- Ferules shall be used at all termination points unless another type of connector is indicated.
- No more than two conductors shall be terminated at each terminal connection.
- All panels shall be equipped with terminal blocks or attachment plugs for all out going control conductors.
- Signal wires need not have a terminal block or attachment plug where signal loss, and or noise, may be of concern.
- All wires shall be labeled at their termination point to correspond to the markings on the diagrams.
- Device and component designation shall be consistent with Annex E of NFPA 79:

4.3.5 Splicing

- Splicing is prohibited.

4.3.6 Spare Wire

- A minimum of 15% spare wire shall exist in each wireway that is external to an enclosure. All wires must be labeled, terminated, and identified in the electrical prints.

4.3.7 Color Code

- See Appendix “B”.

4.4 Wiring for Low Electrical Noise

4.4.1 The mechanical layout of test stands and panels within must include electrical noise considerations. Control and high current circuitry shall be physically separated and shielded as much as possible from transducers and signal conditioners.

4.4.2 Position signal conditioners and shunt cal relays as close as possible to transducers.

4.4.3 Position high current drivers such as solenoid and motor drives in a shielded compartment as near the load as possible.(24 Vdc solenoids are preferred when possible – less noise)

4.4.4 Bring control and data acquisition wiring to computer from different directions to reduce coupling. Wires placed at 90 degree angles will magnetically couple the least.

4.4.5 Always route and bundle noisy driver and digital control signals separately from low-level analog signals.

4.4.6 Reduce loop area of signals and their respective return lines by twisting or running closely parallel.

4.4.7 Route wires close to grounded metal surfaces rather than out in space.

4.4.8 All sub-assemblies must be well grounded to the test stand chassis. Assemblies attached only with painted rack mount ears must be grounded with a strap.

4.4.9 Ground power supply commons at a single point on the chassis near the power supply unless otherwise specified.

4.4.10 Do not use switching power supplies unless specifically requested.

4.4.11 All transducers shall be connected to a signal conditioner using twisted pairs in a shielded cable. A pair for excitation, a pair for output, and a third pair for shunt cal if required. All transducer cable shields shall be grounded only at one end.

4.4.12 Closely follow all recommendations for motor drive wiring. Be sure to include all filters. Ground shield of high-current drive output cables at both ends.

4.5 Electrical Schematic Format

4.5.1 Electrical Layout Diagram – This diagram shall show an overview of the Test System identifying all electrical enclosures, motors and electrical components.

4.5.2 Control Wiring Diagram – This section should contain all logic circuits used in the test system.

4.5.3 Power Wiring Diagram – This section should contain all power feed and devices.

4.5.4 Interconnection Diagram – This section should contain all terminal blocks, connectors, and indicate which elements are connected to them.

4.6 Electric Cylinder Guidelines:

4.6.1 With minimal stroke travel, grease may not circulate to properly lubricate Exlar Cylinder bearing surface.

4.6.2 Exlar powered at 480VAC, 3 Phase is preferred.

4.6.3 Servo controller should be real-time and should receive relevant control and shutdown parameters directly.

4.6.4 For shutdown, power to amplifier should have a delay factor allowing the drive signal to be zero first.

4.6.5 Exlar control should include external limit and home proximity switches. As travel limit is exceeded, logic should remain detected.

4.6.6 Exlar cylinders should include external anti-rotate fixturing.

4.6.7 If power goes below a predetermined value, shutdown should occur. *Proposed due to possible storm/ facility power interruptions.

4.6.8 For high speed applications, one should specify amplifier with sufficient current output.

4.6.9 Exlar GSX model cyclinders with parallelled windings are physically smaller than GS models but are rated for shorter life (less of a problem for short functional tests).

4.7 PC Software (Exception: PLC's)

4.7.1 General

- The main program should be written with Microsoft Visual Basic. Active X objects or real-time critical modules may be written with Microsoft Visual C++ but must be well documented.
- All software developed for a Bosch Corporation Test System will be the property of Bosch Corporation and may be duplicated and re-used as Bosch Corporation deems appropriate.
- All software developed for a Bosch Corporation Test System will be provided with source code and relevant necessary libraries. Libraries necessary for code execution must be available at no additional charge for duplication and re-use by Bosch Corporation.
- The software version should be encoded into the program code to be part of the test display. Also, record the description of the test system software revision in a text file maintained with the source code.
- Revision format will be: X.Y.Z
  - X represents a large revision that begins at 1. Y and Z are set to 0.
  - Y represents a small revision that begins at 0 and is incremented Z is set to 0.
  - Z represents a developmental status of the software. Z begins at 0 and may be incremented whenever development software is being tested.

4.7.2 Input Data Configuration

- Whenever possible, input configurations shall be stored/accessed using Windows ASCII INI file format.

4.7.3 Process Communications

- Whenever possible, process communication shall be implemented using any or all of the following: Ethernet TCP/IP, Ethernet UDP/IP, Component Object Model (COM), Named Pipes or Shared Memory.

4.7.4 Test Data Output

- Whenever possible, test data output will be in Windows ASCII INI format. It will include a header section containing, at a minimum, date, test stand number, sample rate, software version, units of the recorded data and scaling necessary to convert between the recorded data units and their associated engineering units. The data section shall include a single header record containing channel names. Both the header and data will be tab delimited. Data is to be stored as time by record and channels by column. Once created, the test data output file is not allowed to change.

4.8 Quality Standards & Run-Off Conditions

4.8.1 The Quality standards & run-off conditions as described in the GDS Manual, Section 6 are not applicable.

4.8.2 Test stand measurement repeatability is performed as described in the AIAG Measurement System Analysis Handbook.

- n=3
- Minimum of 10 groupings (30 data points)
- Calculate
  - Data average xbar
  - Grand average xdoublebar
  - Data Range R
  - Upper Control Limit UCL
  - Lower Control Limit LCL
- Plot xbar & R charts
- Evaluate

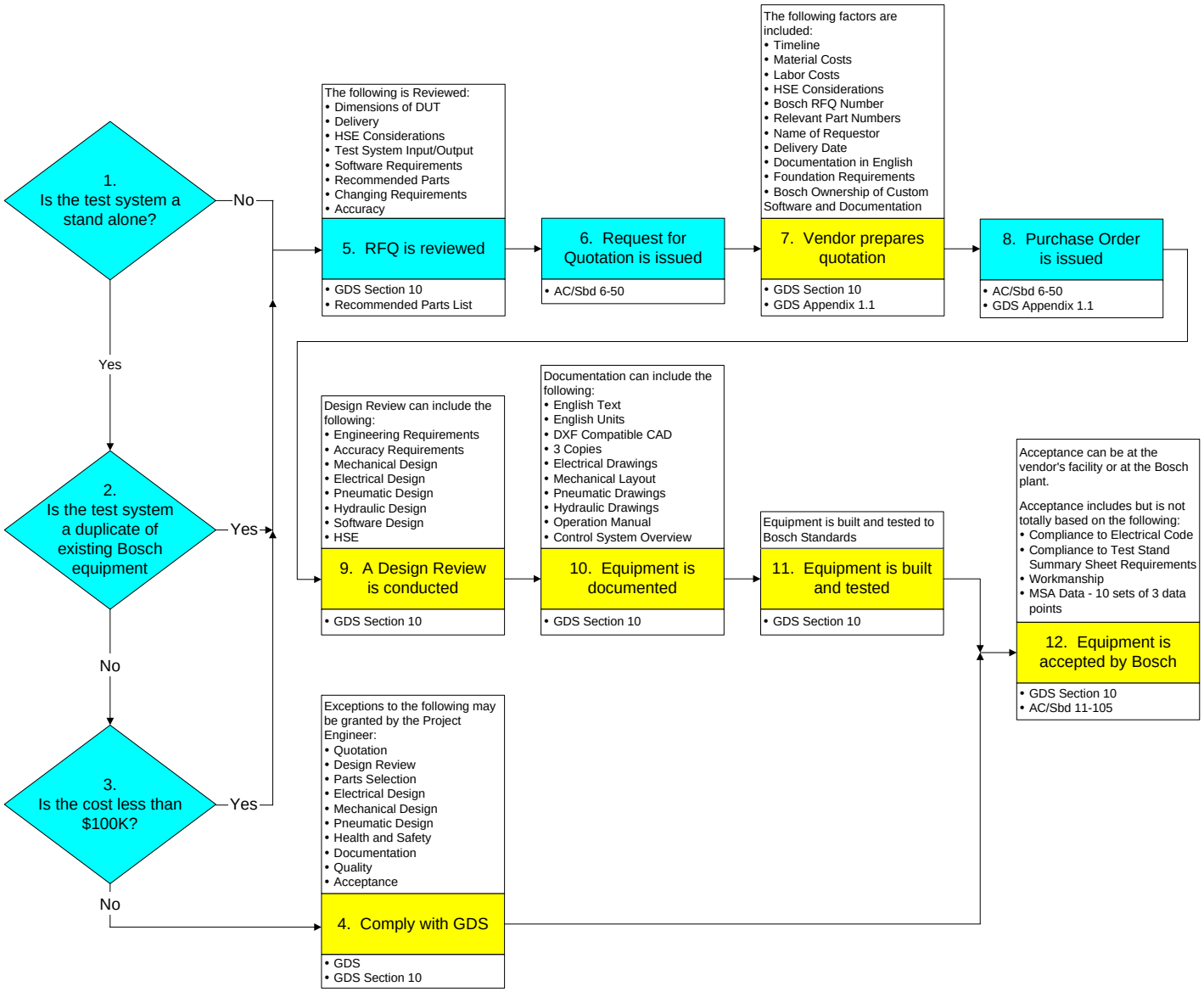
4.8.3 Test stand measurement repeatability is performed for all required tests listed on the Test System Summary Sheet (sheet provided by Bosch).

- Test system capability and variance columns are completed.

4.9 Final Acceptance Checklist

4.9.1 Upon completion of the Equipment at Seller's facility, Buyer shall have the right to inspect the Equipment using Appendix "C" as a minimum list of requirements. The Buyer and Seller may agree to have the Buyer perform a pre-completion inspection or several inspections during the build process. In addition to any purchase order requirements, delivery to the buyer's facility as well as final payment requires that Appendix "C" issues be reviewed and approved by the Buyer.

4.10 Procedure



4.11 Roles and Responsibilities

Roles and Responsibilities Matrix						
Flowchart block #	**Function**	**Bosch Engineering**	**Bosch Purchasing**	**Bosch User Group**	**Bosch Test Equipment Representative**	**Vendor**
1.	Is the test system a stand alone?		I	(s)	R	I
2.	Is the test system a duplicate of existing Bosch Equipment?		I	(s)	R	I
3.	Is the cost less than $100K?		s	(s)	R	I
4.	Comply with GDS.		(R)	s	(R)	R
5.	RFQ is reviewed.	s	(R)	s	R	I
6.	Request for quotation is issued.	s	R	s	s	I
7.	Vendor prepares quotation.		I	(I)	I	R
8.	Purchase order is issued.		R			I
9.	A design review is conducted.	s	(I)	s	s, I	R
10.	Equipment is documented				I	R
11.	Equipment is built and tested.				I	R
12.	Equipment is accepted by Bosch.	s	s	s	R	s

Key:
R = Function is **responsible** for execution/completion of the activity/action.
A = Function is responsible for **approval** in the action/activity.
s = Function is responsible to **support/cooperate** during the activity/action.
I = Function **receives/processes information** that is an output of the action/activity.
( ) Indicates the responsibility is carried out on an as needed basis.

Appendix "A"
Bosch Approved Parts

Part Type	Manufacturer
Air Cylinders	Ortman Advanced Engineering Control Air
Air Fittings	Parker SMC
Cable Clamps	3M AMP Amphenol Cinch ITT Northern Technologies Panduit Thomas Bett
Circuit Breakers	Bussman Merlin Gerlin Potter & Brumfield Siemens Square D (Schnieder Electric)
Connectors	AMP Amphenol Cannon Cinch SPC Technologies Superior Electronics
Contactors	ABB AEG IEC Merlin Gerwin Siemens Square D (Schnieder Electric) Telemecanique
Contacts/Pins	AMP
Current Shunts	EMPRO
Cycle Counters	Durant Electromatic ITT Potter Brumsfeld Red Lion Reddington Veeder Root
Data Acquisition Cards	National Instruments
Displacement Transducers	Balluff Macro Sensors Unimeasure

Part Type	Manufacturer
Electric Actuators	Parker Exlar
Electric Actuator Drives	Copley Emerson
Enclosures	Bud Hammond Hoffman
Flow Meters	Cox Fluidyne Hedland Max Machinery
Flow Rate/Totalizers	Flow Technology Max Machinery
Flow Transmitters	Max Machinery
Fuse Holders	Buss Littelfuse Phoenix Siemens
Fuses	Buss Gould-Shawmut Littlefuse Siemens
Hydraulic Fittings	Hansen Parker
Indicators	Chicago Miniature Lamp, Inc. GE Micro Lamps, Inc. Radion Square D (Schnieder Electric) Sylvania
Panel Meters	Acculex Datel Modutec Omega Syrelec
PLC Displays	Cuttler-Hammer Square D (Schnieder Electric)
PLC Perpheral I/O	Bosch Phoenix Siemans SMC Square D (Schnieder Electric) Wago

Part Type	Manufacturer
Pneumatic Valves / Solenoids	MAC Parker SMC
Potentiometers	Beckman Instruments, Inc. Bourns Clarostat Computer Instruments, Inc. Duncan Electronics Inc. Helipot Corporation IRC Ohmite Spectrol Trimpot
Power Supply / Conditioning	Control Techniques HarrisLambda/EMI Schaeffner Siemens Sola Sorensen Square D Telemecanique Triplite
Pressure Transducers	GP - 50 Sensotec Viatran
PLC Controllers	Modicon Steeplechase WAGO
Proximity Switches	Balluff Turck
Relay Sockets	Omron Potter & Brumfield SPC Square D (Schnieder Electric)

Part Type	Manufacturer
Relays	Bosch IDEC Opto 22 Phoenix Potter & Brumfield Siemens Square D (Schnieder Electric) STI Telemecanique
Servo Controllers	MEI MTS
Servo Valves	HR Textron MOOG MTS
Signal Conditioning	Daytronic Interface National Instruments Phoenix Sensotec Telmar
Supercons	Superior Electric Co.
Switches	Alco Honeywell IFM Efector Siemens Square D (Schnieder Electric) STI
Teflon Hose (Stainless Steel Braid)	River Bend
Terminal Blocks	Phoenix Contact Siemens WAGO
Thermocouples	Omega Thermo Electric

Part Type	Manufacturer
Transducers - Force	Interface Key Lebow Sensor Data Sensotec
Transducers - Torque	Lebow Sensor Data
Vacuum Transducers	MKS Sensotec Viatran
Wire	Alpha Belden Olflex Waytec
Wire Terminations	AMP Ideal Panduit SPC
Wire Ferrules	American Eclipse SPC Wiedmuller

Appendix "B"
Wiring Methods

Color code

Control wiring:

Conductor insulation color should conform to NFPA 79 Sec. 16.1.2 and 16.1.3.

For example:

Black: Ungrounded control, load and line conductors @ line voltage.

Red: Ungrounded AC control conductors below line voltage.

Blue: Ungrounded DC control conductors.

White: Grounded AC conductors.

White w/Blue: DC return conductors.

Green: Chassis Ground.

Note: Line voltage should be considered to be 200VAC and above.

Instrumentation wiring:

Instrumentation wire color code shall conform to the following table. Bosch will be informed if an alternate cable is used which deviates from the standard.

Signal	6-Pin Conn.	9-Pin Conn	Pair	Cable 8434*	Cable 89503*	Cable 83556*	Cable 83506*
+ Excitation	A	1	TP1	Red	Red	Red	Red
+ Signal	B	2	TP2	Green	Green	Green	Green
- Signal	C	3	TP2	White	Black	White	White
- Excitation	D	4	TP1	Black	Black	Black	Black
Cal 1	E	5	TP3	Shd (6 pin)	White	Blue	Blue
Cal 2	F	6	TP3		Black	Orange	Orange
Shield	Case	9	Drain	Shd (9 pin)	Shield	Shield	Shield
				25AWG	24AWG	22AWG	24AWG

*Belden Cable Number

Appendix "C"
Acceptance Check-List

Item		Acceptable		
		Yes	No	N/A
1.	GDS Section 10 Compliance			
2.	Compliance to Bosch approved parts List			
3.	Bill of Material List			
4.	Wire Termination and Labeling			
5.	Wire color code			
6.	Compliance to NFPA Electrical Code			
7.	Compliance to Test System Summary Sheet			
8.	Compliance to Bosch MSA requirements(Section 10 4.6)			
9.	Compliance to Safety & Health Standards:			
10.	Health & Safety reviewed with Bosch project engineer?			
11.	All hazard areas must be guarded (push, stroke, capture, retract, clip and squeeze areas, sharp edges, hot/cold surfaces, etc).			
12.	E-stop located within close reach of operator near point of operation?			
13.	Emergency Stop (E-stop) buttons for electrical, pneumatic, and hydraulic test systems are accessible and properly labeled?			
14.	E-stop does not require software processing to disable test system motion?			
15.	E-stop requires manual release and operator intervention to restart?			
16.	Demonstrates proper test execution sequence and timing?			
17.	Test data is in ascii text format for export compatibility?			
18.	D-U-T mounting dimensioning agrees with our products?			
19.	3 copies of Documentation provided in DXF Compatible CAD with English text.			
20.	Documentation includes the following: Electrical Drawings Mechanical Layout Pneumatic Drawings Hydraulic Drawings Operation Manual Control System Overview			
21.	Test System appearance is neat, professional?			

5 Change History

Edition No.: 1	**Date:** 8/30/2002	**Written by:** AC/ETS6.3-Jack Brewer
Changes: • Original document.		

Edition No.: 2	**Date:** 8/8/2003	**Written by:** AC/ETS6.3-Jack Brewer
Changes: • Revised sections 4.3 Wire Termination and Labeling. • Added section 4.4 Wiring for Low Electrical Noise. • Added section 4.6 Electric Cylinder Guidelines. • Revised section 4.7 PC Software. • Revised section 4.9 Final Acceptance Checklist. • Revised appendices A, B, and C.		

Edition No.: 3	**Date:** 9/13/2004
Approved: AC/ETS7.1-Jack Brewer	
Changes: • Sections 4.2.1.2: Added description and part number for E-Stop button and safety relay. • Section 4.6.7: Replaced “E-Stop” with “shutdown”. • Revised Appendix A Parts List.	