



Fanuc Robot Specification

Global Common

SD-1040

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**Manufacturing Equipment
Purchase Specification
Nexteer Automotive**

TITLE: FANUC ROBOT SPECIFICATION	NUMBER: SD-1040	APPROVED BY: MIKE KETTLER
ISSUED BY: JASON FALL	DATE: 03/09/17	
REVISION: 001	DATE: 03/09/17	
SHEET: 2 of 13		

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1. General

1.1 Scope

This specification contains principles, guidelines, and requirements for the design, redesign, and implementation of robotic workcells containing one or more Fanuc robots for use in process or manufacturing at Nexteer Automotive.

1.2 Purpose

The purpose of this specification is to make common incoming robotic workcells to provide the Nexteer Automotive manufacturing community- including engineers, skilled trades, safety personnel and equipment suppliers with the knowledge, tools, and methods to achieve safe, robust robotic workcells.

1.3 Informative Reference

See Annex A for a list of informative references. Users of this document shall consult applicable Federal, State, and Local laws, regulations, and standards in addition to those listed in Annex A.

1.4 Application

The requirements of this specification shall be applied to all new Machinery & Equipment (M&E) and manufacturing systems containing one or more Fanuc robot arms.

1.5 Deviations

Any deviations from this standard shall be addressed during Design Reviews and risk assessment with alternative solutions documented and approved by the Engineer in Charge, controls engineer, and H&S representative. Any approved deviations shall only apply to that specific instance, and they shall not be considered a change to this specification or acceptable for future M&E purchases

2. Robot Selection

2.1 Selecting a Robot

Supplier is required to analyze workcell requirements to determine max payload and reach needed for application. Nexteer project engineer should provide supplier with robot selection utility if necessary. Nexteer project engineer shall confer with plant personnel regarding preferred/common robot models in the plant. Nexteer shall purchase robot after machine supplier verifies robot size and options with Fanuc.

Robots shall be selected as appropriate for the region they will be used in.

- North American robots have serial numbers of F-XXXXXX
- European robots have serial numbers of E-XXXXXX

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- Asian market robots have serial numbers of M-XXXXXX

2.2 Required Options

Nexteer requires all incoming robots to have the following options at a minimum; other options may be needed specific to individual applications.

- RTL-R860 Advanced EIP Package or RTL-R786 Ethernet/IP Adapter Software
- RTL-R809 Motion Package
- RTL-R859 Advanced DCS Package or RTL-J567 DCS Position & Speed Check
- RTL-R632 Karel

3. Robot Integration

3.1 Robot Control

Control of robot signals shall be handled by the machine tended by the robot(s). If more than one machine in a workcell is tended by a robot, a cell controller shall be used to coordinate control.

Robot to PLC interface shall be Ethernet/IP; other interface options require approval by the Nexteer Controls Engineer.

3.2 Robot START signal

Robot start signal shall use the PNS method. A main program should be called from PNS0001. This program should begin the main loop for the robot. Additional PNS signals may be used for discrete tasks when the cell is not in automatic cycle (e.g. move to maintenance position)

3.3 Human Machine Interface (HMI)

The cell or machine controller shall have a separate screen on the HMI for each robot being controlled. A template HMI screen shall be provided to the supplier by Nexteer project engineer.

3.3.1 Standard Buttons

The screen shall have the following functions, each with a separate button on the screen:

- Home - Recover & Return robot to home position; should be used for any stop that does not allow robot to complete cycle
- Maintenance - Move robot to a maintenance position; generally giving access to end of arm tooling
- Request for Cycle Stop - Allows robot to complete cycle before stopping; may need to run out multiple parts before stop; preferred stop method in most situations
- Immediate Cycle Stop - Stops robot where ever it is in cycle, without needing to run out parts; should not be used frequently

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- Gripper Open/Close - as approved by Nexteer controls engineer

3.3.2 Messaging and Fault Handling

HMI shall not display a robot fault when the fault is a 'common fault' caused by external equipment to the robot

Example: Robot teach pendant shows "SRVO-037 SERVO IMSTP INPUT". "IMSTP" off; This causes the robot to: 1) Pause the program if one is running, 2) immediately stops the robot and applies the robot brakes, 3) shuts off power to the servos. Therefore the robot generates a fault. The HMI shall display the root cause fault.

Common faults include, but are not limited to:

- SYST-045 TP enabled in AUTO mode
- SYST-038 Operation mode T1 Selected
- SRVO-007 External emergency stops

3.4 Robot Programming

Robot programs should be clearly structured, well commented, and clearly labeled. Background programs may be used when applicable. Karel programs may be used; however the supplier shall provide source code for any Karel programs used to facilitate support & trouble shooting requirements.

3.4.1 Recovery

Robot shall recover from anywhere within its normal operating space without intervention from an operator, excluding situations where robot or tooling is physically jammed.

Recovery shall be done from HMI. Operator shall not be required to use robot teach pendant.

Any method that shall meet the requirements above is acceptable. Below is a preferred example:

- Cartesian coordinate method - Current location is compared to known Position Registers. Robot to proceed to the closest known target at a velocity that is appropriate for the robot location. Once at the closest known location, the robot shall go home on a predetermined path.

Integrator shall confirm with responsible Engineer on specific recovery method

3.4.2 Code Structure

All programs shall run through one looping program that shall be identified as "PNS0001". Supplier shall provide a flow chart of robot program & operation.

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Example flow chart:

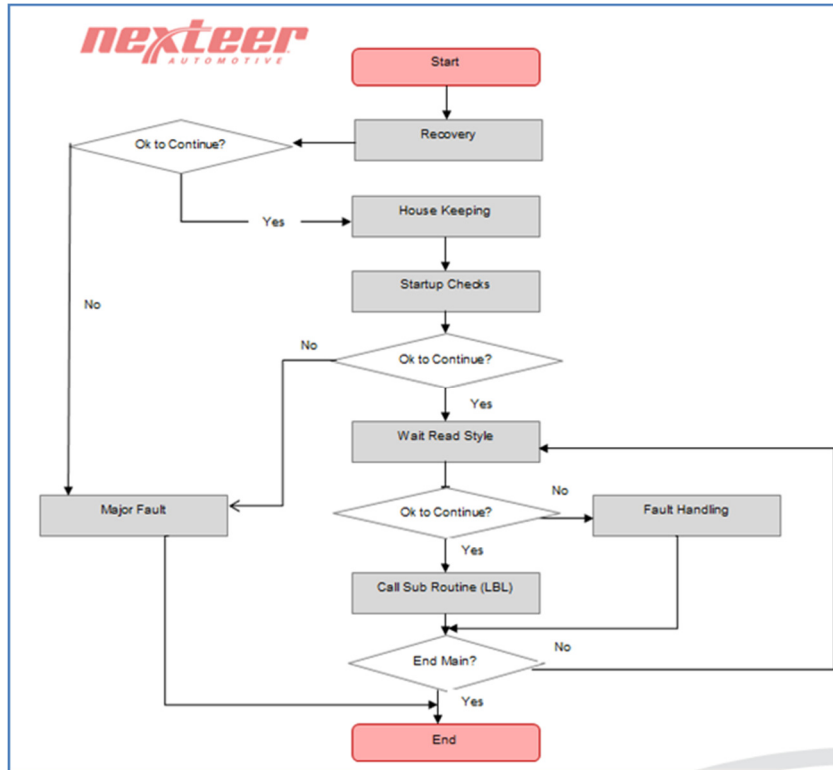


Figure 1: Flow Chart Example

3.5 Comments/Headers/Descriptions

3.5.1 Comments

Commenting inside the program shall be required. Comments shall briefly describe the step currently being performed by the program.

3.5.2 Descriptions

Names of programs & program elements shall follow the conventions below. Naming shall be relevant to task being performed and included part number or model number where practicable.

- Pick_xxxx
- Drop_xxxx
- Load_xxxx
- Unload_xxxx

Registers, Position Registers, I/O, etc. will follow these conventions as well.

- PR[1:Home]

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- R[3: Current Infeed]
- DI[1: Part Ready]
- RO[1: Close Gripper]

3.5.3 Headers

'PNS0001' program shall contain a header which contains the following information:

- Integrating company's name, address, and phone number.
- Name, address, and phone number of any subcontractors involved in programming.

Example Main program header:

```
!-----  
! Machine Builders Inc.  
! 123 Main Street  
! Hometown, IN USA  
! 555-555-5555  
!  
! Programmed by:  
! Robot Automation Inc.  
! 456 Main Street  
! Hometown, IN USA  
! 555-555-4444  
!-----
```

All other programs shall contain a header with a brief description of the task to be performed by the program.

Example header for other programs:

```
!-----  
! Closes Robot Gripper  
!-----
```

3.6 General Programming Requirements

3.6.1 User Frames/User Tools

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User frames shall be used only when necessary, such as when the machine or fixture within the cell is not aligned with robot world frame (zero or ninety degrees). Use of user frames shall require approval by Nexteer project engineer. Any user frame that is used should have its origin, X & Y directions labeled on the machine wherever it is possible

User tools shall be defined for the application when the robot needs to manipulate or orient around a part or if the Tool Center Point (TCP) needs to change for other tasks.

If a user tool is used, the supplier shall supply any necessary fixtures to set up the user tool TCP. Example: Pointer set for teaching user tool.

3.6.2 Use of Position Registers

Robot targets shall be position registers, to allow for sharing of positions in robot recovery routines. Positions along a path may be program points.

4. Workcell Safety

4.1 General Safety

Refer to SD-011 Specification for Safety Circuits and SD-012 Design-In Health and Safety Specification for general safety requirements

4.2 Guarding

Robot shall be enclosed with guarding that meets specifications set in ANSI/RIA 15.06.

Supplier shall confer with Nexteer project engineer for any specific floor plan restrictions that would affect placement of guarding. Examples: Support beams, walkways, building equipment, ductwork.

4.3 DCS

Dual Check Safety (DCS) Position/Speed check shall be used when applicable to limit restricted space of robot and/or identify zones or areas of operation. Suppliers should be trained in DCS use by Fanuc or a certified Fanuc trainer. Any DCS zones, passwords, or safety I/O setup shall be documented per section 5.2 Documentation requirements

5. Qualification

5.1 Runoff

Refer to SD-001 General Manufacturing and Equipment Specifications and SD-002 Manufacturing Equipment Statistical Qualification Requirements for general qualification requirements, in addition to the requirements below.

5.1.1 Mounting

Robot shall be mounted to Fanuc specifications. Baseplate shall be from Fanuc or an exact match of their drawing and shall include the proper datum features.

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Tie-Bars (locating jigs) should be used to position the robot in relationship to the other machines/objects in the cell.

5.1.2 Mastering

Supplier shall demonstrate the robot is mastered properly, and provide a zero position program.

5.1.3 Collision Detection

Collision Detection shall be used in any programming containing motion. Collision detection requires accurate payload and center of inertia information to work properly.

5.1.4 Payload & Inertia

Accurate payload and center of inertia data is critical to proper robot performance. Supplier shall be responsible for providing this information and setting up the proper motion profiles for the robot both with and without parts.

5.1.5 DCS (Dual Check Safety)

If DCS is implemented, supplier shall provide locations and purpose of DCS zones. Functions of all DCS zones shall be tested at runoff.

5.1.6 Faults/Recovery

The supplier shall provide a complete robot process fault list

Supplier shall provide a fault recovery matrix that shall explain how to recover from the robot process faults.

Recovery shall be demonstrated by stopping the robot at various times in the cycle and observing that the robot can recover without operator intervention.

5.2 Documentation Requirements

Backups of all robots shall be provided by the supplier. A backup of the robots as received from Fanuc & as shipped from the supplier build site shall be provided. These backups should include ASCII (*.LS) program files. Files shall be provided on a USB flash drive.

A hardcopy and digital copy of the following shall be provided by supplier:

- Robot & Controller F-Numbers as well as the Teach Pendant serial numbers
- Robot Programs, with description of task being performed
- Source code of any Karel programs used
- Payload & inertia information for both empty tool and tool with parts
- Flow chart of robot programs

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- Any applicable robot registers used in program (Registers, Position Registers, Vision Registers, etc.)
- Inputs/Outputs (Digital, Robot, Group, User, etc.) and corresponding tags in PLC
- Positions of User frames
- Positions of User tools
- Location and purpose of all DCS zones used, if applicable
- DCS Master Code and any local codes, if applicable
- Any safety I/O- description and function

Additionally, all documentation provided by robot manufacturer shall be provided by the supplier.

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Annex A: References

The references used in the development of this specification are listed below.

Note: Users of this specification shall consult applicable Regional, Federal, State, Country, and Local laws, regulations and standards in addition to those listed below. Reference the most current version of the specifications / standards listed below.

Nexteer Automotive Documents:

Manufacturing Engineering Website: nexteersuppliers.com

- SD-004, Electrical Specification for Industrial Machinery, addendum to IEC 6020401
- SD-011, Specification for Safety Circuits
- SD-014, Pneumatic fluid power - General rules relating to systems, addendum to ISO 4414
- SD-015 Lean Equipment Design
- SD-016, Lean Equipment Controls Design
- Guarding/Cycle Initiate Methodology
- SD-017, Design-In Ergonomics Guidelines (DEG)

National Documents:

ANSI – American National Standards Institute website: www.ANSI.org

- ANSI B11.1, Machine Tools – Mechanical Power Presses – Safety Requirements for Construction, Care, and Use
- ANSI B11.19, Machine Tools, Safeguarding when referenced by the Other B11 Machine Tool Safety Standards - Performance Criteria for the Design, Construction, Care, and Operation
- ANSI B11.20, Manufacturing Systems/Cells-Safety Requirements for Construction, Care, and Use
- ANSI/RIA R15.06, American National Standard for Industrial Robots and Systems
- ANSI Z244.1, Lockout/Tagout of Energy Sources

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