PROJECT REPORT ON

DEVELOPMENT OF PROGRAMMABLE LOGIC CONTROLLER FOR SWAGING MACHINE

BY:

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A PROJECT REPORT ON

DEVELOPMENT OF PLC FOR SWAGING MACHINE

DONE AT SSTP,BPS

NUCLEAR FUEL COMPLEX

DEPARTMENT OF ATOMIC ENERGY

HYDERABAD

Under the Esteemed Guidance of

SHRI.JEETHENDRA BHAVRANI

(SCIENTIFIC OFFICER/D,SSTP)

Submitted as the partial fulfilment for the award of degree of

Bachelor of Technology in

Electronics and Communication Enginnering

BY PRUDHVI SAI NIKITH & SWAPANTHI VARMA

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Government of India

Department of Atomic Energy

NUCLEAR FUEL COMPLEX

BONAFIDE CERTIFICATE

This is to certify that **K Prudhvi Sai Nikith(16P71A0446) & N Swapanthi Varma(16P71A0478)** has done their project work under my guidance during the period from 27-05-2019 to 26-06-2019 on the topic entitled **"DEVELOPMENT OF PLC FOR SWAGING MACHINE"** with reference to Nuclear Fuel Complex .

It is ensured that the report does not contain classified or Plant operational live data in any form .

Signature:

Name:

Hyderabad — Designation of guide:

Date: — Plant:

Approved by

The Manager of the Plant

ACKNOWLEDGEMENT

First of all, we extremely thankful to Shri Dr. Dinesh Srivastava, Chairman, NFC Board & Chief Executive, NFC for giving me this opportunity to carry out Internship at Nuclear Fuel Complex.

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Finally, We would like to thank everyone who have directly or indirectly helped me in the successful completion of this Mini Project

ABSTRACT

The main purpose of swaging machine is to reduce the diameter up to particular level, while performing swaging operation clamping fixture play most important role for mounting pipe on swaging machine. Pipe swaging apparatus includes a swaging fluid motor for moving a swage die toward a pipe clamping assembly including a stationary bottom clamping plate and a movable top clamping plate.

Clamp operating hydraulic cylinder mounted at above the clamping plate and having a piston rod coupled with the top clamping plate to permit automatic operation of the pipe clamping assembly and simultaneously with operation of the swaging fluid motor. An automatic swaging machine including a conveyor system for moving tubes during swaging operation.

Now a days the clamping of component is done manually. For that more cycle time is required for clamping and unclamping the material so there is a need to develop a system which can help in improving productivity and time. Therefore automatic clamping fixture will reduce operation time and increase productivity.

DECLARATION

We, hereby declare that the project entitled **"DEVELOPMENT OF PLC FOR SWAGING MACHINE"** is a record of an original work done by me under the guidance of **Shri.JEETENDRA BHAVRANI** at **NUCLEAR FUEL COMPLEX** and this project is submitted in the partial fulfillment of requirement for the award of the degree of Bachelor of Technology in Electronics and Communication Engineering

The results embodied in this thesis have not been submitted to any other university for the award of any degree

N SWAPANTHI VARMA

[16P71A0478]

CONTENTS

Government of India
Department of Atomic Energy
NUCLEAR FUEL COMPLEX
(An ISO 9001. 14001 and OHSAS 18001 Organization)

History

The Nuclear Fuel Complex (NFC), established in the year 1971 is a major industrial unit of Department of Atomic Energy, Government of India. The complex is responsible for the supply of nuclear fuel bundles and reactor core components for all the nuclear power reactors operating in India. It is a unique facility where natural and enriched uranium fuel, zirconium alloy cladding and reactor core components are manufactured under one roof starting from the raw materials.

Scope

The Nuclear Fuel Complex is unique in many respects. It is the only Complex of its kind where Uranium concentrates on the one hand and Zirconium mineral on the other are processed at the same location all the way to produce finished fuel assemblies and also zirconium alloy tubular components, for supplies to the Nuclear Power Industry. The complex also symbolizes the strong emphasis on self-reliance in the Indian Nuclear Power Programme. The advanced technologies for the production of nuclear grade uranium di-oxide fuel, zirconium metal and zirconium alloy tube components and the manufacture of fuel bundles conforming to reactor specifications were developed through systematic efforts during the late 50's and the 60's.

The complex has different types of production facilities which include the Zirconium Oxide Plant for processing of Zircon to pure Zirconium oxide; the Zirconium Sponge Plant for conversion of Zirconium oxide to pure sponge metal; facilities for reclamation of zircaloy mill-scrap; the Zircaloy Fabrication Plant for producing various zirconium alloy tubings and also sheet, rod and wire products; the Uranium Oxide Plant for processing crude uranium concentrate to pure uranium di-oxide powder; the Ceramic Fuel Fabrication Plant for producing sintered Uranium oxide pellets and assembling of the fuel bundles for the PHWRs; the Enriched Uranium Oxide Plant for processing of imported enriched uranium hexafluoride to enriched uranium oxide powder; the Enriched Uranium Fuel Fabrication Plant for producing enriched UO_2 pellets and the fuel assemblies for the BWR reactors; and a plant for fabrication of components and sub assemblies for Fast Breeder Reactors. A Special Materials Plant for producing a number of electronic grade high purity materials for supplies to the Electronic Industry and plants producing stainless steel seamless and other special tubes have also been set up in this complex.

The common plant facilities comprising of the Quality Control Laboratory, the Central Workshop, the Compressor and Boiler House, the Civil, Electrical and Mechanical Engineering Services render strong support to the Plant operations.

Location

Located near the famous shrine of moulali at Hyderabad, Telangana State, INDIA. The housing colony for its employees and Guest House are adjacent to the complex. The business hours of the Organization starts at 08:45 hrs and concludes at 16:45 hrs IST. All Sundays and Second Monday of every month are observed as holidays.

Nuclear Fuel Complex
Department of Atomic Energy
PO: ECIL, Moula-ali
Hyderabad - 500 062.

NFC - Vision & Mission

India is pursuing a three stage nuclear power programme linking the fuel cycles of Pressurised Heavy Water Reactors (PHWR) and Liquid Metal Cooled Fast Breeder Reactors (LMFBR). In addition, Light Water Reactors (LWR) have also been included in the programme in order to achieve the target of 20,000 MWe of nuclear power by the year 2020

From the very inception of the nuclear power programme in India in the mid 1960s, great emphasis has been given towards self-reliance and indigenisation in fabrication of nuclear fuels.

Ever since its commissioning in 1971, the Nuclear Fuel Complex (NFC) is playing a key role in this programme and has been supplying natural and enriched Uranium Oxide fuels and Zirconium alloy core components for all the power reactors in India. Indigenous resources, knowhow, and process equipment are being extensively utilized.

NFC is perhaps the only facility in the world wherein under the same roof, both Uranium Oxide fuels and Zircaloy alloy components are fabricated starting from the basic raw materials namely Magnesium-di-uranate and Zircon sand respectively.

In addition, NFC has manufactured and supplied stainless steel core components for the Fast Breeder Reactor programme, Seamless alloy steel and Titanium tubes and other special high purity materials for both nuclear and non-nuclear applications.

NFC has a highly qualifed and committed team of Scientists, Engineers and Technicians. This resource, combined with state-of-the-art equipment and technology and total quality management objective, NFC is poised to meet challenges in the years to come.

Nuclear Power Station

The Indian Pressurized Heavy Water Reactors(PHWR) use natural uranium as fuel. They do the same job as coal, oil or natural gas in the generation of electricity, producing heat to convert water into steam, which drives the turbine generator to produce electricity. Unlike coal, oil or natural gas, there is no combustion of Fuel in the nuclear reactor. Heat is produced by the fission (splitting) of atomic nuclei in the reactor. Heavy water coolant transports the heat from the fuel to heat exchangers (boilers) where steam is Produced, which drives the turbine and generator.

INDIAN PRESSURIZED HEAVY WATER REACTORS

- ✓ Tarapur Atomic Power Station
- ✓ Narora Atomic Power Station
- ✓ Kudankulam Atomic Power Project
- ✓ Madras Atomic Power Station
- ✓ Kakrapar Atomic Power Project

How is Energy Generated?

A nuclear power plant is much similar to a coal fired thermal plant except the way heat is produced to raise steam. At the heart of a nuclear power plant is the fission reaction in the nuclear fuel, usually uranium, that takes place in the reactor core. To be simplistic, in a nuclear fission, a neutron hits the nucleus of an atom of the uranium fuel and splits it, in which two or three neutrons are released and used to cause fission in other uranium atoms. Fission of a single atom of uranium yields energy equal to 200 MeV (million electron volts) in comparison to only 4eV in the oxidation of one carbon atom. Therefore, on equal weight basis the total energy from the nuclear fission of 1 tonne of uranium is about as much as that produced from 2.5 million tones of coal combustion. Natural uranium consists of two forms (isotopes) of uranium vis-à-vis U-238, (99.3%) and U-235 (0.7%). It is the less abundant U-235 that leads to fission reactions. U-235 is the only natural isotope that can be made to undergo fission by thermal (slowed) neutrons. However concentration of U-235, as compared to U-238 can be increased by the process called enrichment. An enrichment of about 3 to 4 percent provides considerable flexibility in the design and operation of nuclear reactors although slowing down of neutrons still remains a necessity.

The surplus neutrons produced in the chain reactions are allowed to interact with other atoms to produce even more neutrons. In such a case, the reaction will continue over a time, until fuel is depleted. However, not all the atoms are available to fission other U-235 nuclei as some of them 'escape' or are absorbed by the surrounding materials. Three scenarios may be envisaged, considering such a neutron economy. First, if more than one neutron is available for reaction, the rate of fission increases with time and the reaction is 'super critical'. Second, exactly one neutron is available for fission reaction such that reaction rate is constant and the reaction is 'critical'. Third, less than one neutron is available for reaction and number of fission decreases with time or the reaction is 'sub critical'. In a nuclear reactor, an increase in the number of neutron is allowed initially to reach the required reactor power and then maintained at that level. The reaction rate is lowered to reduce power level or to shut down the reactor by decreasing the number of available neutrons e.g. by inserting a neutron absorbent like boron or cadmium.

Fission neutrons have energy and must be slowed down to enhance the chances of inducing further fissions. This slowing down of neutrons is accomplished by a 'moderator', ideally a substance having low neutron absorption. Such reactors which use thermal (slowed down) neutrons by their repeated collision with moderator are called thermal reactors. The pressurized heavy water reactor (PHWR), mainstay of India's nuclear power programme, is a thermal reactor using natural uranium as fuel and heavy water as moderator and coolant.

Making of Nuclear Fuel

Natural Uranium is mined at jaduguda in Jharkhand. It is converted into nuclear fuel assemblies at Nuclear Fuel Complex. A 220 MW PHWR fuel assembly contains about 15.2kg of natural uranium dioxide. Uranium dioxide pellets generate heat while undergoing fission and also generates fission products. Fission products are radioactive and should be contained and also not allowed to mix with coolant water. Hence the UO_2 pellets are contained in Zirconium alloy tubes with both the ends hermatically sealed.

Unlike other fuels, nuclear fuels 'burn' without any obvious change in the size, shape or appearance of the elements. They do not give rise to bulky ash or harmful fumes. In a nuclear power station such a assembly produces as much electricity as that of 15 wagon loads (i.e about 380 tonnes) of coal. A 220 MWe reactor unit contains 3,672 fuel assemblies like this. They normally stay in the reactor for about 18 months before being replaced. Careful design and scrupulous quality control guard against failures in service.

There is no combustion in uranium fuel and a fuel assembly comes out of the reactor in the same way as it went in. However, there is one important difference, When a fuel assembly is removed from the reactor after about 18 months of use, it contains radioactive by-products as a result of the fission process. Because of this radioactivity, the fuel assembly is handled by remote controlled fuel assembly loading/unloading machine to transfer it for storage in a water-filled pool inside the station. This machinery also feeds new fuel assembly into the reactor. The water cools the used fuel and, along with steel and concrete shielding, protects station workers from radiation. After a period of storage under water, the spent fuel assembly are taken in shielded containers to the reprocessing plant. In this plant, operated largely by remote control through heavy shielding, three main product streams are separated.

- Depleted Uranium (about 98%) is stored for recycling in fast breeder reactor.
- plutonium (about 0.4%) formed when neutrons are absorbed in atoms of non-fissionable uranium. This very valuable and can be used as fuel for fast reactors.
- Mixed long-lived radioactive fission products (about 1%) is vitrified and stored.

Raw Material:-

1. Raw Material for the manufacture of natural uranium dioxide fuel for PHWR's is Magnesium di-urinate supplied by UCIL at Jaduguda (Jharkhand).
2. The starting material for enriched uranium dioxide fuel for PHWR's is imported uranium hexa-fluoride.
3. IREL supplies zircon sand required for the manufacture of reactor grade zirconium sponge, and finished zirconium alloy mill products.

PRODUCTS

PHWR Fuel Assemblies

The raw material for the production of PHWR fuel in NFC is Magnesium Di-Uranate (MDU), popularly known as yellow cake. The MDU concentrate is obtained from the uranium mine and mill at jaduguda, Jharkhand. The impure MDU is subjected to nitric acid dissolution followed by solvent extraction and precipitation with ammonia to get Ammonium Di-Uranate (ADU). Further steps of controlled calcination and reduction form sinterable uranium dioxide (UO_2) powder.

The UO_2 Powder is converted to high-density cylindrical pellets by various operations like; pre compaction, granulation, binder addition, final compaction and sintering at high temperature (1700 degree centigrade) in hydrogen atmosphere. The sintered pellets are then centreless ground to desired dimensions and dried.

The cylindrical UO_2 pellets are stacked and encapsulated in thin walled tubes of zirconium alloy, both ends of which are sealed by resistance welding using end plugs. Before locating the pellets the zirconium alloy tubes are machined at ends, cleaned, coated with graphite lubricant on the inside surface and vacuum baked at 350 degree centigrade. Appendages such as spacers and bearing pads are spot welded on these elements and 19 or 37 such elements of specified configuration assembled together by welding them on to end plates at either end to form fuel assembly.

19-element fuel assembly is designed for 220MWe reactor. Each fuel assembly contains 15.2Kg of UO_2. Initial core requirement of each Mwe reactor is 3672 fuel assemblies. The reload requirement is around 3000 fuel assemblies per year. NFC has so far produced more than 5,00,000 fuel assemblies as on 31st March 2012. Each assembly generates 6,40,000 units of electrical energy.

NFC is gearing up to manufacture 37 - element fuel assemblies required for 540 Mwe reactors. Each fuel assembly contains 22.0 Kg of UO2 and can generate 8,81,000 units of electrical energy. Initial core requirement and reload requirement per annum, are 5096 and 4010 fuel assemblies respectively.

NFC has also produced assemblies containing Thorium dioxide flux flattening during initial start up of reactor. NFC has so far produced 253 assemblies.

BWR Fuel Assemblies

BWR fuel assemblies are fabricated at NFC, Starting from imported enriched uranium hexafluoride. The enriched uranium hexafluoride is hydrolised subjected to and converted to Ammonium Di-Urante by treating with ammonia. On account of higher enrichment (U-235 content 2-3%) special precautions are exercised in designing the process equipment and in the operation due to criticality considerations. ADU after pyrohydrolysis is treated in the same way as PHWR fuel to obtain high density, UO2 pellets. The fuel assemblies for Tarapur Atomic Power Station are of different design consisting of 6X6 or 7X7 array of fuel elements. These are assembled using intricate components such as stainless steel tie plates and zirconium alloy spacers.

FBR Fuel Bundles

Fast Breeder Test Reactor 40 MW (th)

At the component facility setup during 1980, all the core sub assemblies required for Fast Breeder Test Reactor (FBTR) are fabricated. A fuel sub-assembly consists of 511 intricately machined components of 35 different types. These were fabricated with the knowhow developed in-house and equipment/fixtures built indigenously. Pelletisation of the thorium oxide has been carried out on a large scale that involved considerable ingenuity and effort. NFC fabricated all the core assemblies for Fuel, Blanket, Nickel and Steel Reflector and Special Assemblies (except plutonium work). These are hexagonal in shape with 48.8 mm A/F and 1650 mm long. Blanket assemblies containing ThO2 pellets have also been supplied.

Prototype Fast Breeder Reactor 500 Mwe

A full-fledged assembly for 500 Mwe Prototype Fast Breeder Reactor (PFBR) for hydraulic tests involving 1541 components in single assembly has been fabricated. Prototype fuel, blanket and control rod Several other types of assemblies are fabricated up for validating/ freezing the design of core assemblies by type tests. These assemblies need special stainless steel materials like modified 316 Ti. These are indigenously made and converted into various components

Stainless Steel / High Alloy Seam less Tubes

Stainless steel and other high alloy seamless tubes are used extensively in power generation - both thermal and nuclear, fertilizer and chemical industries, Defence and aerospace applications in view of their outstanding properties of corrosion resistance and mechanical strength at cryogenic as well as elevated temperatures.

Nuclear Fuel Complex at Hyderabad has excellent facilities for manufacture of seamless tubes in a variety of materials.

PROGRAMMABLE LOGIC CONTROLLER

INTRODUCTION

A **Programmable Logic Controller (PLC)** is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnosis.

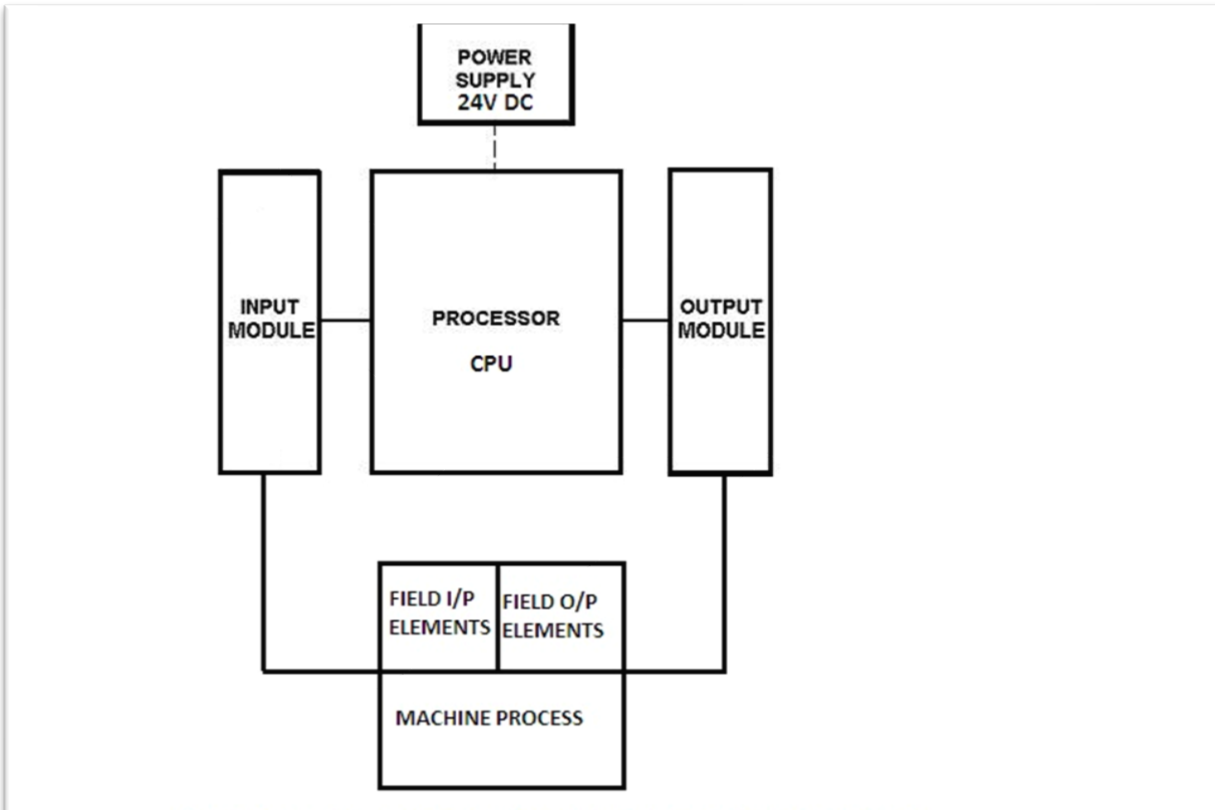
HISTORY

In 1968 GM Hydramatic issued a request for proposals for an electronic replacement for hard-wired relay systems based on a white paper written by engineer Edward R. Clark.The first PLC, designated the 084 because it was Bedford Associates' eighty-fourth project, was the result Bedford Associates started a new company dedicated to developing, manufacturing, selling, and servicing this new product:One of the people who worked on that project was **Dick Morley,** who is considered to be the "father" of the PLC The Modicon brand was sold in 1977 to Gould Electronics, later acquired by German Company AEG, and then by French Schneider Electric, the current owner.

Early PLCs were designed to replace relay logic systems. These PLCs were programmed in "ladder logic", which strongly resembles a schematic diagram of relay logic. This program notation was chosen to reduce training demands for the existing technicians. Other early PLCs used a form of instruction list programming, based on a stack-based logic solver.

Modern PLCs can be programmed in a variety of ways, from the relay-derived ladder logic to programming languages such as specially adapted dialects of BASIC and C. Another method is state logic, a very high-level programming language designed to program PLCs based on state transition diagrams. The majority of PLC systems today adhere to the IEC 61131/3 control systems programming standard that defines 5 languages: Ladder Diagram (LD), Structured Text (ST), Function Block Diagram (FBD), Instruction List (IL) and sequential function chart (SFC).

BLOCK DIAGRAM



BLOCK DIAGRAM OF PROGRAMMABLE LOGIC CONTROLLER

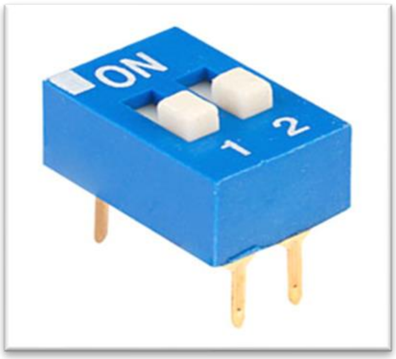
INPUT DEVICES

- Push Buttons

- Limit Switch

- Transducers

- Switches



- Proximity Switches

OUTPUT DEVICES

- AC/DC Drives

- AC/DC Motors

- Lamps

- LED Indicators

➢ LCD Display

TYPES OF PLC'S

- Compact PLC

- Modular PLC

- PLC Plug-in-cards

ADVANTAGES

There are six major advantages of using PLCs over relay systems as follows:

- Flexibility
- Ease of troubleshooting
- Space efficiency
- Low cost
- Testing
- Visual operation

Flexibility: One single PLC can easily run many machines.

Ease of Troubleshooting: Back before PLCs, wired relay-type panels required time for rewiring of panels and devices. With PLC control any change in circuit design or sequence is as simple as retyping the logic. Correcting errors in PLC is both fast and cost effective.

Space Efficient: Fewer components are required in a PLC system than in a conventional hardware system. The PLC performs the functions of timers, counters, sequencers, and control relays, so these hardware devices are not required. The only field devices that are required are those that directly interface with the system such as switches and motor starters.

Low Cost: Prices of PLCs vary from few hundreds to few thousands. This is minimal compared to the prices of the contact, coils, and timers that companies pay to match the same things. Using PLCs also saves on installation cost and shipping.

Testing: A PLC program can be tested, evaluated, and validated in a lab prior to implementation in the field.

Visual observation: When running a PLC program a visual operation displays on a screen or module mounted status lamps assist in making troubleshooting a circuit quick, easy, and relatively simple.

DISADVANTAGES

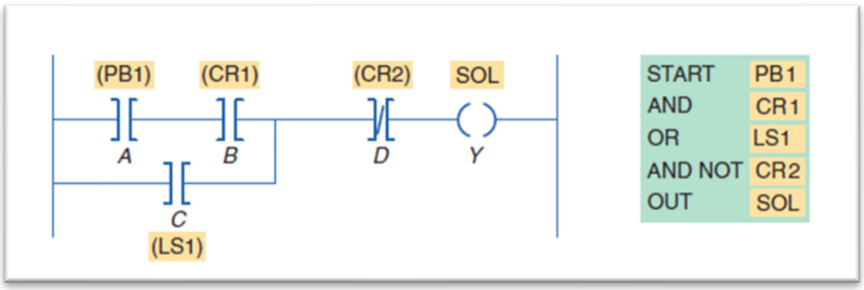
- Fixed circuit operation.
- PLCs manufacturers offer only closed loop architecture.
- PLCs are propitiatory, which means software and parts one manufacturer can’t be easily used in combination with part of another manufacturer.
- Number of optional modules must be added to maximize flexibilty

PROGRAMMABLE LANGUAGES

Ladder Logic

Ladder logic is the main programming method used for PLC's. As mentioned before, ladder logic has been developed to mimic relay logic. The decision to use the relay logic diagrams was a strategic one. By selecting ladder logic as the main programming method, the amount of retraining needed for engineers and trades people was greatly reduced.

The first PLC was programmed with a technique that was based on relay logic wiring schematics. This eliminated the need to teach the electricians, technicians and engineers how to program - so this programming method has stuck and it is the most common technique for programming in today's PLC.



Mnemonic Instruction

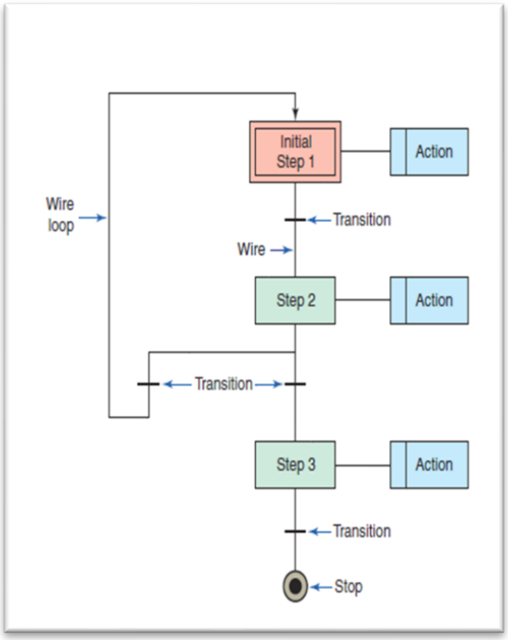
There are other methods to program PLCs. One of the earliest techniques involved mnemonic instructions. These instructions can be derived directly from the ladder logic diagrams and entered into the PLC through a simple programming terminal.

Instruction Code Mnemonics

IEC 1131-3	Mitsubishi	OMRON	Siemens	Operation	Ladder Diagram
LD	LD	LD	A	Load operand into result register.	Start a rung with open contacts.
LDN	LDI	LD NOT	AN	Load negative operand into result register.	Start a rung with closed contacts.
AND	AND	AND	A	Boolean AND.	Series element wit open contacts.
ANDN	ANI	AND NOT	AN	Boolean AND with negative operand.	Series element wit closed contacts.
OR	OR	OR	O	Boolean OR.	Parallel element with open contacts.
ORN	ORI	OR NOT	ON	Boolean OR with negative operand.	Parallel element with closed contacts.
ST	OUT	OUT	=	Store result register into operand.	An output.

Sequential Function Charts (SFC)

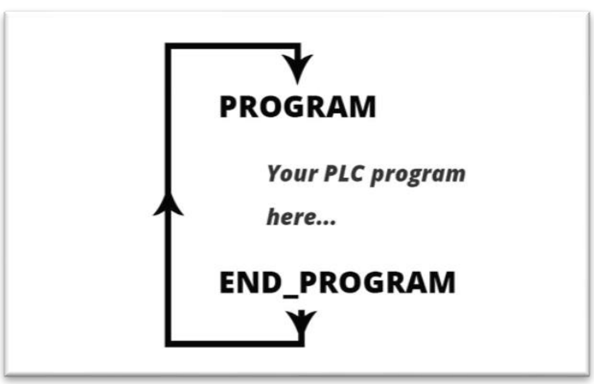
SFC have been developed to accommodate the programming of more advanced systems. These are similar to flowcharts, but much more powerful. This method is much different from flowcharts because it does not have to follow a single path through the flowchart.



Structured Text (ST)

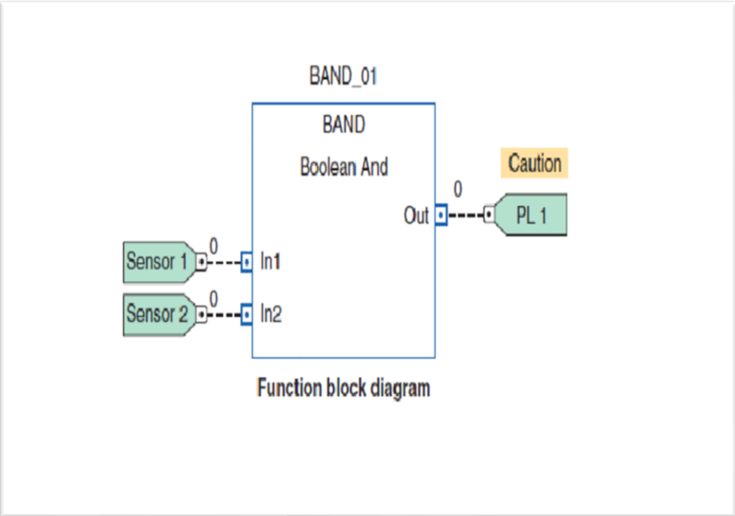
Programming has been developed as a more modern programming language. It is quite similar to languages such as BASIC and Pascal.

Structured Text (ST) is a high level textual language that is a Pascal like language. It is very flexible and intuitive for writing control algorithms.



Function Block Diagram (FBD)

FBD is another graphical programming language. The main concept is the data flow that start from inputs and passes in block(s) and generate the output



Function block diagram

SIMATIC STEP-7 PLC

INTRODUCTION

SIMATIC STEP-7 PLC has been the common standard and the leading engineering system for PLC . With SIMATIC STEP-7 modular controller and simatic PC based controllers may be configured, programmed, tested and diagnosed. This standard is now integrated into our TIA portal engineering framework area of application.

FEATURES

- Use of one uniform engineering for micro to high end controller including PC based control with SIMATIC with CC
- Efficient engineering due to powerful editors of IL,LAD,FBD, GRAPH(SFC) and SCL.
- Revised language editors with significantly improved ease of use.
- Photo-realistic illustration of hardware configuration for greater clarity.
- Intelligent drag 7 drop functionality between STEP-7 WIN CC editor.
- Convenient import of actual values.
- Investment protection due to full support of existing automation solution.

Feature	CPU 1211C	CPU 1212C	CPU 1214C
Physical size (mm)	90 x 100 x 75		110 x 100 x 75
User memory • Work memory • Load memory • Retentive memory	 • 25 Kbytes • 1 Mbyte • 2 Kbytes		 • 50 Kbytes • 2 Mbytes • 2 Kbytes
Local on-board I/O • Digital • Analog	 • 6 inputs/4 outputs • 2 inputs	 • 8 inputs/6 outputs • 2 inputs	 • 14 inputs/10 outputs • 2 inputs
Process image size	1024 bytes (inputs) and 1024 bytes (outputs)		
Signal modules expansion	None	2	8
Signal board	1		
Communication modules	3 (left-side expansion)		
High-speed counters • Single phase • Quadrature phase	3 • 3 at 100 kHz • 3 at 80 kHZ	4 • 3 at 100 kHz 1 at 30 kHz • 3 at 80 kHz 1 at 20 kHz	6 • 3 at 100 kHz 3 at 30 kHz • 3 at 80 kHz 3 at 20 kHz
Pulse outputs	2		
Memory card	SIMATIC Memory card (optional)		
Real time clock retention time	10 days, typical / 6 day minimum at 40 degrees		
PROFINET	1 Ethernet communications port		
Real math execution speed	18 μs/instruction		
Boolean execution speed	0.1 μs/instruction		

SWAGING MACHINE

Introduction

Nuclear fuel complex is in requirement of one cold swaging machine for swaging of the bar of Zircaloy and steel material to obtain required dimensions and mechanical and metallurgical properties.

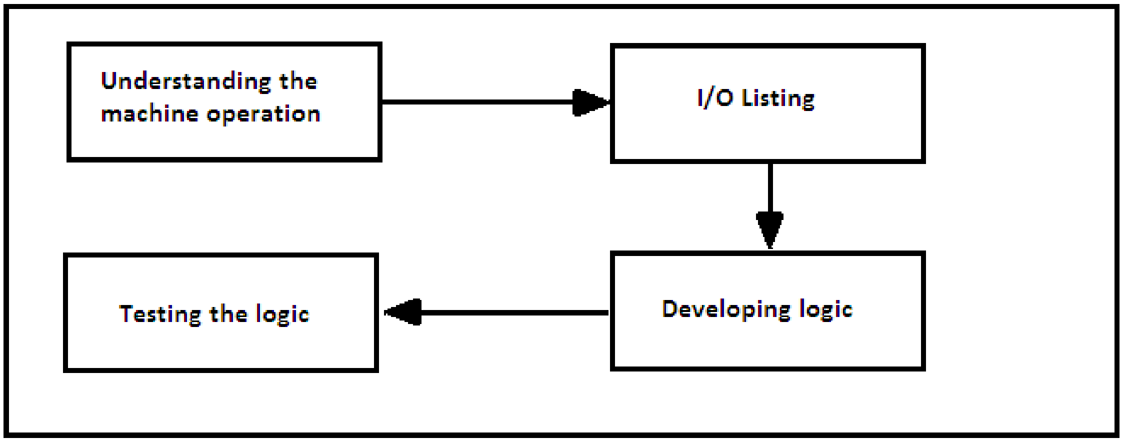
Scope of supply

"Design, manufacturing, testing, supply, erection, commissioning and performance demonstration of Cold Swaging Machine along with bar material handling system complete in all respects including all accessories and auxiliaries, electrical, electronics and hydraulic equipment if any, pneumatic, internal piping and fittings, internal and interconnecting cabling etc."

The swaging machine shall consist of following major sub-system

- 4 Die through feed Cold Rotary Swaging Machine
- Machine Control system
- Front side and Rear side bar feeding system
- Automated bar Loading and unloading system

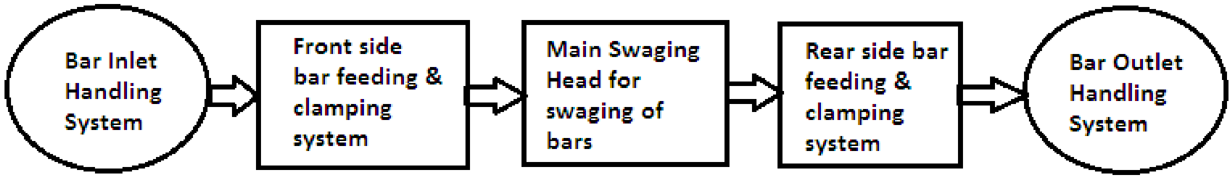
STEPS OF SWAGING MACHINE



Basic Swaging Machine

a. The 4 Die rotary swaging machine shall be provided for long length through feed swaging operations.
b. The swaging machine provided shall be of double rotating type with rotating main spindle shaft and rotating outer ring.
c. Variable frequency drive shall be provided for the motor driving the outer ring and the spindle of the swaging head can be of fixed RPM or of variable RPM type. The direction of the rotation of the spindle shall be opposite to the direction of rotation of outer ring and roller cage assembly.
d. The front side and rear side clamping & feeding system shall be provided for through feed swaging operation of bar. The system shall be suitable to run in both auto and manual mode for the specified range of bars.
e. Bar inlet and outlet handling system shall be provided along with the machine for automatic loading and unloading at front and rear ends. The system shall be suitable to entire bar diameter and length range specified.
f. A vibration monitoring system shall be provided to monitor and display the vibrations of the machine and to stop the machine in case of excess vibration.
g. Machine shall have a PLC and HMI based control system.
h. A rough layout of the system along with front and rear side clamping & feeding system, bar inlet and outlet handling system and main machine shall be as follows

LAYOUT OF SWAGING MACHINE



Machine Base

The machine base shall support various machine units. The machine base shall be designed for heavy duty sturdy industrial working and shall be able to withstand high axial forces generated during swaging operation. The machine shall be mounted on vibration absorbing pads for vibration isolation. The vibration absorbing pads for the machine is in the scope of supplier.

Swaging Head

The swaging head of the machine shall be designed as per the specified range of the diameters and material mentioned in section 3.0. The main swaging head of the machine shall consist of Outer ring, Roller cage assembly along with pressure rollers, spindle, thrust pieces and die segments and shims etc.

a) The outer ring shall be suitably designed to absorb all the radial loads during deformation. This shall be driven by a VFD through suitable mechanism. The details of the mechanism and range of the RPM adjustable shall be clearly given in the offer. The general inspection drawing, MOC and hardness for the outer ring shall be submitted by the successful tenderer.

b) The spindle of the swaging head shall be suitable for through feed swaging operations of the bar. The spindle rotation may be of fixed RPM or of variable RPM type. The details of the mechanism and the range of the RPM adjustable, if variable RPM shall be clearly given in the offer. The direction of rotation of the spindle shall be opposite to the direction of rotation of the roller cage assembly and outer ring.

c) The die segments shall be guided in the slots cut in the end face of the spindle of swaging head. Between the die segments and thrust pieces, shim plates shall be provided for compensating the wear in the dies and also to control the output diameter of the swaged bars. The dimensions of shim plates and die shall be clearly specified for the range of bar as per the section 3.0.

d) The dies shall be suitably designed for different ranges of incoming bars but finish diameters as per design basis 3.0 (h). The details shall be clearly given in the

Head for swaging of bars profiles. The general inspection drawing and hardness for all set of dies for specified ranges of diameter shall be submitted by the successful tenderer.

e) The thrust pieces shall be designed with trigonometric shape for larger contact length with rollers resulting in low noise and low wear etc. The details shall be clearly given in the offer. The general inspection drawing, MOC and hardness for the thrust pieces shall be submitted by the successful tenderer.

f) The roller cage assembly along with pressure rollers shall have movement resulting from the rotation of the swaging shaft, outer ring and shape of the thrust pieces. The general inspection drawing, MOC and hardness of the roller cage and pressure rollers shall be submitted by the successful tenderer.

g) The range of the stroking frequency adjustable for the system shall be clearly given in the offer. The details of the mechanism for varying the stroking frequency shall be given.

h) The system shall be provided with suitable mechanism to limit the stroke length to avoid damage to pressure rollers and outer ring. The details shall be given in the offer.

i) Swaging head shall be easily accessible for die changing and maintenance activities. The necessary provision shall be provided for easy removal of the die pieces, shim plates and thrust pieces. The details shall be clearly given in the offer.

Front side and Rear side Feeder System:

a) The feeder system on the front side and rear side of the machine shall be provided for the through feed swaging operations of the wok pieces.

b) The front side and rear side feeder system shall be suitable for working in both directions in rapid and slow working speed.

c) All feeder movements and positions shall be controlled and monitored by sensors.

d) Hydraulic work piece clamping device on the front side of the feeding system shall be provided. This clamping pressure shall be continuously adjustable for controlled rotational speed of the work piece during swaging or this hydraulic gripper shall be of controlled slip type. The details shall be given in the offer.

e) The front side feeder shall allow for proper feeding of the bar. However the machine shall accommodate the specified length of ingoing bar automatically. Details of working shall be given clearly in the offer.

f) Hydraulic clamping device on the rear side feeder to pull the swaged bar right behind the swaging dies of the swaging machine shall be provided. The rear clamping device shall pull out the swaged bar from the die exit at a suitable distance.

g) Both the front and rear feeder system shall work synchronously to feed the bars without interruption during swaging operation.

h) Suitable system for the quick change of the clamping inserts shall be provided. The general inspection drawing, MOC and hardness for the clamping jaws for front and rear gripper shall be clearly given for the specified range of the bars by successful tenderer.

i) This complete system shall be suitable to run the machine in both auto mode and manual mode for the specified range of the bars.

Bar Inlet and Outlet Handling System:

Bars Automatic loading and un-loading system shall be provided along with the machine at entry (front) & exit (rear) ends. The system shall be suitable to entire bar diameters and length range. The system shall contain as follows

a) The bundle of bars, to be swaged will be loaded onto inlet magazine using EOT Crane (not in scope of supply) and manually unscrambled and will be kept suitably for transfer.

b) The suitable mechanism shall be provided to transfer one bar at a time from inlet magazine to front side hydraulic feeder clamps for swaging operation. This shall be suitable for working with specified range of bar diameters.

c) Then hydraulic clamping and feeder system on the front side & rear side shall automatically feed and pull out the bars for swaging operation.

d) After swaging operation, a suitable mechanism shall be provided to transfer the bar from rear side hydraulic clamps to outlet magazine.

e) The outlet magazine shall be provided to receive swaged bars and collect them together.

f) The inlet and outlet magazine shall be lined with suitable material for scratch free operation and shall have a capacity to handle 40 nos. of bars of 27 mm dia.

g) The complete system shall be suitable for operation in both auto and manual mode.

h) The complete details for the bar inlet and outlet handling system shall be clearly given in the offer.

I/O LISTING

S No	NAME	DATA TYPE
1	proximity_sensor_frontside_at_HOME	bool
2	proximity_sensor_frontside_at_END	bool
3	IR_sensor_workpiece_present	bool
4	Rear_sensor_2_at_the_END	bool
5	Front_side_reverse_rapid_cutoff_sensor_input	bool
6	Rear_clamping_close_pb_no	bool
7	Rear_clamping_open_pb_nc	bool
8	Front_clamping_close_pb_no	bool
9	Front_clamping_open_pb_nc	bool
10	Manual_mode	bool
11	Swaging_machine_off_pb_nc	bool
12	Swaging_machine_on_pb_no	bool
13	Hydraulic_motor_off_pb_nc	bool
14	Hydraulic_motor_on_pb_no	bool
15	B1_tool_inching_motor_pb	bool
16	fb_k1_swaging_motor_on	bool
17	fb_k2_swaging_motor_star	bool
18	fb_k3_swaging_motor_delta	bool
19	fb_k4_swaging_motor_rev_on	bool
20	fb_k5_hyd_motor_on	bool
21	fb_k8_tool_inching_motor_on	bool
22	fb_k9_tool_inching_motor_star	bool
23	fb_k10_tool_inching_motor_delta	bool
24	emg_pb_nc	bool

25	motion_direction_switch_swaging_motor	bool
26	semi_auto	bool
27	auto_mode	bool
28	rear_side_forward_start_pb_nc	bool
29	rear_stop_pb_nc	bool
30	rear_side_reverse_start_pb_nc	bool
31	front_side_forward_start_pb_nc	bool
32	front_stop_pb_no	bool
33	front_side_reverse_start_pb_no	bool
34	front_rapid_pb_no	bool
35	tool_inching_idle_motor_off_pb	bool
36	tool_inching_idle_motor_on_pb	bool
37	rear_rapid_on_pb	bool
38	rear_sensor_1_at_HOME	bool
39	tag_16	bool
40	rear_clamping_close_output	bool
41	rear_clamping_open_output	bool
42	front_clamping_close _output	bool
43	front_clamping_open_output	bool
44	front_side_reverse_off_output	bool
45	rear_side_forward_output	bool
46	rear_rapid_output	bool
47	front_side_forward_output	bool
48	k1_swaging_motor_on	bool
49	k2_swaging_motor_star	bool
50	k3_swaging_motor_delta	bool
51	k4_swaging_reverse	bool
52	k5_hydrauic_motor_on	bool
53	k8_tool_inching_motor_on	bool
54	k9_tool_inching_motor_star	bool
55	k10_tool_inching_motor_delta	bool
56	h2_swaging_motor_on	bool
57	h3_hydraulic_motor_on_indication	bool
58	front_side_reverse_output	bool
59	front_rapid_output	bool
60	swaging_motor_output	bool
61	rear_reverse_rapid	bool
62	tool_inching_motor_output	bool

CONCLUSION

Since the swaging machine is driven by SIAMTIC S5 PLC which is now had become odsolete . Therefore SIMATIC S7 PLC logic has been develpoed to replace the existing S5 PLC logic by analysing the available information and sequence of operation

Here I have successfully implemented PLC ladder logic for swaging machine operation inspite of incomplete documentation of machine

We have also simulated and downloaded the ladder programming in STEP7 MICRO/WIN 32 software. Also checked output of the machine

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BIBILOGRAPHY

- **WIKIPEDIA**
- **YOUTUBE**
- **F-167 SWAGING MACHINE SERVICE MANUAL**