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Co-D a Modern Supervision System For Monitoring Nuclear Fuel Handling Machine

Fuel Handling Machine Co-Driver "Co-D"

During the refuelling outages in a nuclear power plant the removal of the fuel assemblies and the steps involved, need attention and carefulness from the fuel handling machine operator. The operations in the refuelling process are made according to a specified plan. This plan is given in a written form in a so called operation list. This list is used by the operators when driving the fuel handling machine. The Co-D -system presented in this brochure controls the refuelling operations and guides the operator. What the Co-D needs as an input for each campaign is only a modified version of the operation list Co-D takes care of the rest.

Co-D and quality

The designer of the Co-D is a company of technical services Sednove Oy (Loviisa, Finland). The system includes components of several significant instrument and system suppliers. For example Siemens Automation, MaxStegman sensors and Multimedia J&J Intressi's tailor-made programs, by which all the PC functions the operator can see, has been carried out. The criterion for choosing the component suppliers is that the manufacturing has been done according to IISO900-1/-2 quality system. The customers quality control before acceptance assures the quality of the products.

Efficiency and safety increasing solution

Sednove Oy has developed in close cooperation with Fortum Power & Heat Oy Loviisa Plant a monitoring system, which facilitates the operation with the fuel handling machine. The Co-D controls that the operations are performed according to the operation list and registers automatically performed operations.

The advantages of Co-D is highlighted especially during the refuelling outages when part of the fuel assemblies are exchanged into new ones and other are moved into new positions. At other times the system supervises the transfers of fuel assemblies to the storage.

Co-D changes the information from the fuel handling machine into a clear form. Its' guidance functions makes the operation of the fuel handling machine faster, thus reducing the time needed for refuelling.



In the spring 1995 the representatives of the companies involved in the Co-D project visited Loviisa Power Plant. (Siemens, Multimedia J&J Intressi, Sensoror, Probyte, Nobel Elektroniikka, Rittal, Phoenix Contact, Profelco, AEL, Salmetek and Laitehuolto Hyttinen).

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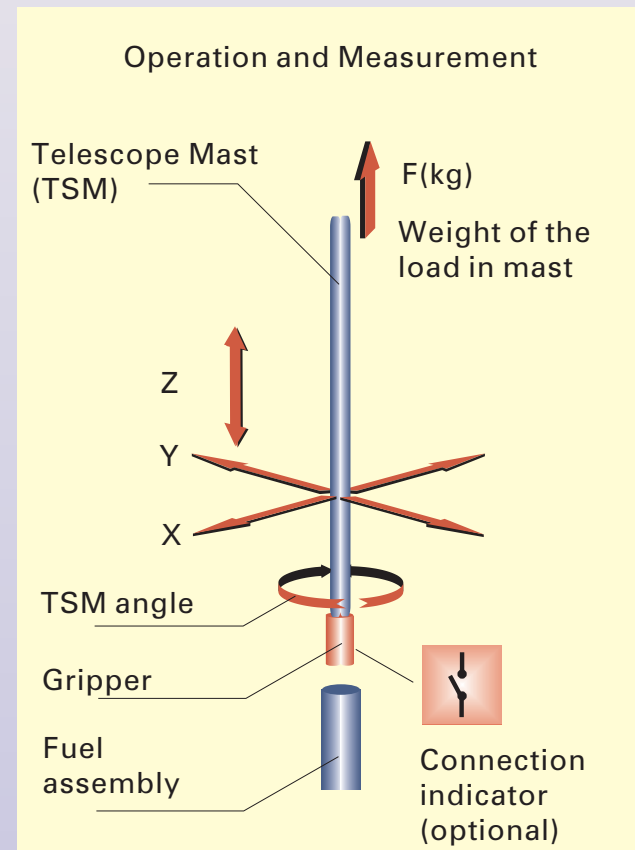
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Co-D part of the fuel handling machine

Co-D is an accessory to the fuel handling machine. It is separated from the existing instrumentation and protection system. Position and status information are measured by the sensors of the Co-D. The load information from the telescope mast, the connection /disconnection signal of the fuel assembly and the X-, Y-and Z- direction command signals are connected to Co-D by galvanic isolated.

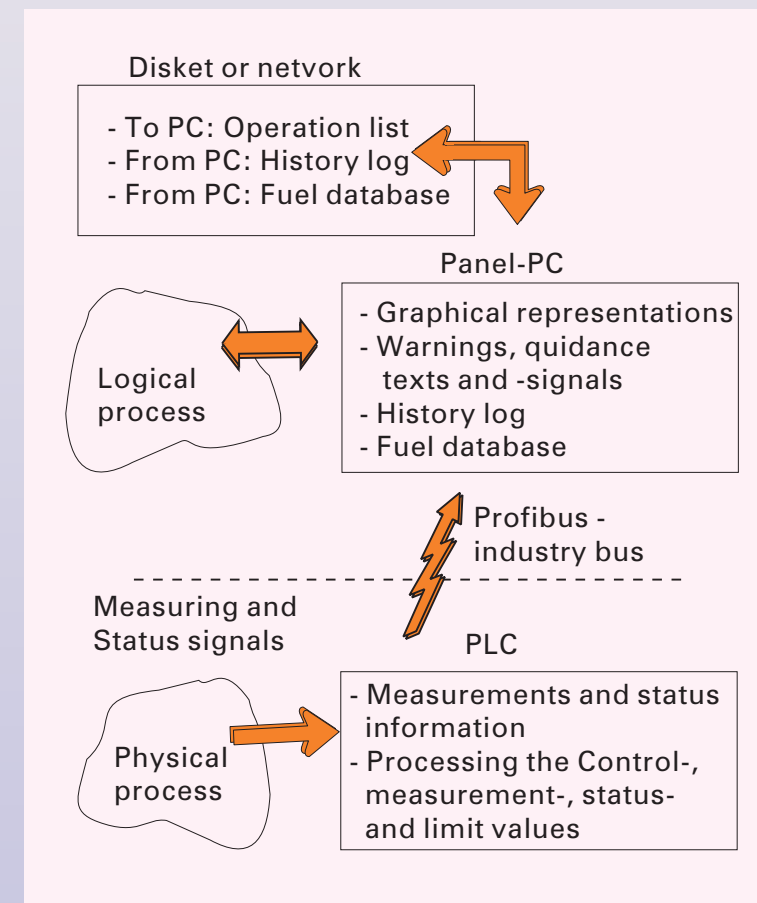
Warning and alarm functions are light and sound signals and also text messages at a PC screen. Signal arrows and note marks show the location of next destination.

Co-D collects information, it does not control directly the fuel handling machine operations. The operator makes all the choices and drives the fuel handling machine.



The physical level

The functions of the physical level are monitored by the Programmable Logic Controller (PLC).



Co-D is divided into two monitoring levels

Technical realisation

The Co-D is divided into two surveillance levels physical and logical both having their own equipment and software solutions. The connection between the levels has been carried out using the Profibus industry bus

Logical level

The logical level includes the data administration of the fuel assemblies. It controls that the performed operations are relevant and it also registers them. The logical level makes a real time fuel accounting possible and also a followup and reporting of the operations. The logical level functions include also graphical representations of the position of the fuel handling machine, telescope mast and the TV-mast etc.

Physical level

The physical level takes care of the processing of fuel handling machine coordinates, the status signals of different functions and the weight information of the load in the telescope mast. Based on these information the physical level produces guidance functions, warning and alarm signals. These functions prevent the operator from making operations, which might cause damage to the fuel assembly or the fuel handling machine.



Readiness for remote control

If the fuel handling machine is provided with a remote control panel it is possible to equip also this with a secondary Co-D panel.

The Logical level

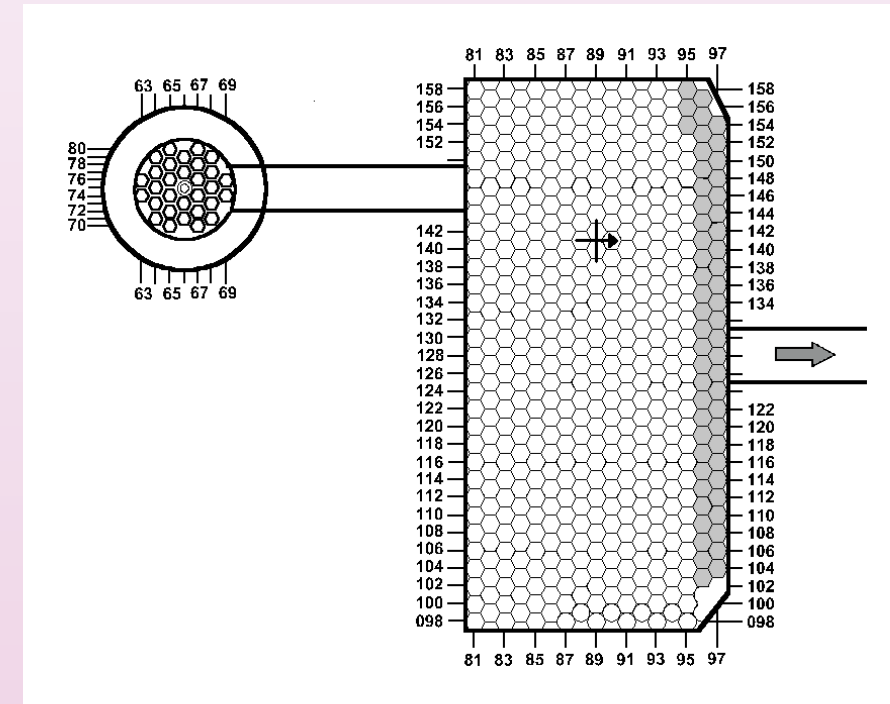
A Industry model panel-PC takes care of the functions on the logical level. Multimedia J&J Intressi Oy has made the monitoring program for the logical level. The expertise of this company comes out especially in very simple and clear graphical representations and in the easy-to-use manmachine interface. The application software is based on the use of the Windows operating system and different kinds of programming languages.

The logical level controls that the operation sequences are performed according to the operation list and uses the information provided by the physical level.

Example Format of The History Log :

1. Assembly number the assembly being processed
2. From position, from where the element has been taken
3. To position, where the element has been taken to
4. Date the date, read from the PC
5. The time read from the PC, the time when the removal sequence is ready

The operation list includes the data fields 1...3 .



Graphic interface

Horizontal movements of the fuel handling machine above the reactor and the ponds can be seen on the PC screen as a cross moving around on the map of the corresponding pond. An arrow on the cross shows the actual direction of the movement.

While running according to the operation list an 'approach / zoom display' will appear on the map when approaching the destination. Also for the connection / disconnection procedures of the fuel assemblies there are illustrative graphical representations.

Data base operations

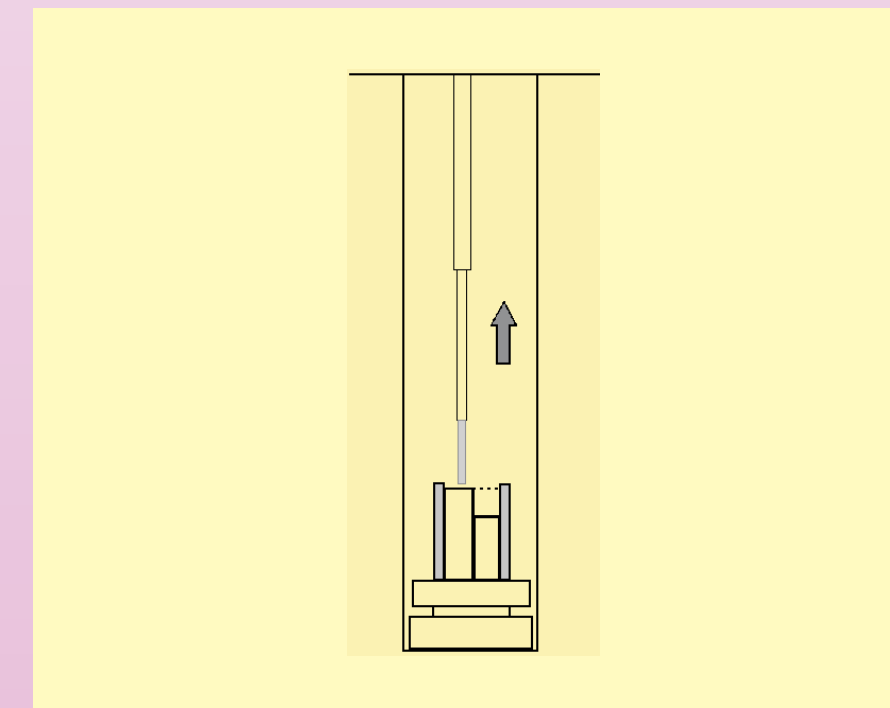
The performed operations are written into the history log and the fuel database is updated at the same time. Even the starting and stopping time of the system will be registered into this log. The log file includes the data fields 1 ... 5 in the definitions.

When fuel assemblies are transferred into or out from the ponds covered by the system, the corresponding fuel assembly data are added or removed from the database. The data base is passwordprotected and available only for authorised persons. The updated database is immediately available for the system. The data base definitions can be specified by the customer

Operation list, history log and data base

The operation list can be inserted to the Co-D either by disk or by network. The reafter the system controls that the operations are made in the right sequence. By a blinking position in the graphical presentation on the PC screen, the system informs the operator where to go in order to perform the next schedule operation.

If you for some reason have to deviate from the sequence in the operation list the system can be switched into a free mode operation. Thereupon the system will not alarm unnecessarily, but continues to update the database according to the operations performed during the free operation mode.



Vertical Movements

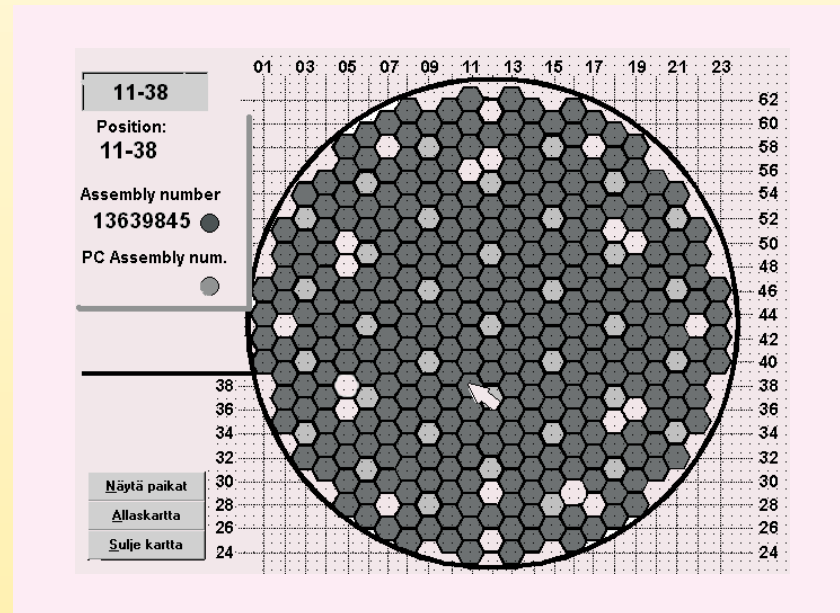
For vertical movements of the telescope mast Co-D is provided with cross section pictures of the reactor and the fuel ponds. The fuel assembly connected to the telescope mast is shown using the real height proportions.

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Map of the fuel assemblies

The real time data base make it possible to maintain a real time map of the fuel assemblies in the ponds. By pointing at a position on map the fuel assembly number, coordinate and other information concerning the fuel assembly in that position will appear on the screen.



Survey part of the system delivery

Different plant layout and fuel handling procedures necessitate always survey meetings to be held during planning of the Co-D system described in this brochure. The survey includes several steps by which the Co-D can be tailored to the customers needs.

Warning and alarm functions



Co-D warns or alarms about malfunctions (examples):

- Wrong operation or wrong direction
- Connection or disconnection of assembly at wrong level
- Horizontal movements at wrong level
- Transfer of assembly into occupied position
- Fetching of assembly from empty position
- Stuck assembly lifting force to high
- Gripping of assembly with telescope mast in wrong 'angle'
- Different assembly numbers in operation list and data base

Startup and training

The fuel handling machine will be provided with desired instrumentation. The panel PC is placed into the control panel. The programmable logic (PLC) and the cross-connection cabinet can be placed either on the fuelhandling machine or outside the reactor building.

During the installation and startup stage the aim is to cooperate with the operator and the maintenance personnel in the most flexible way. This cooperation serves as good training and gives the customers personnel chance to get acquainted with the Co-D.

In the delivery also the training is taken into account and the customer is given readiness to make maintenance and service to the Co-D system.

The survey includes e.g. the following tasks:

- The data field specifications, operating list, history log, fuel assembly numbers and types
- Layout of reactor, fuel pond, and other working areas
- Operation sequence specification: X, Y, Z and telescope angle
- Specification of the limiting values for the working area and operation conditions
- Language used e.g. terminology of the text and guidance messages
- The instrumentation of the fuel handling machine and the possibilities to use it in the Co-D system.

Introduce Sednove



Sednove
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What ?

Sednove Oy Ltd. is company of technical service, that offers automation and ADP products and services.

The activity concerns planning and implementation of trade products, consultancy, training and installation and service.

Sednove offers solutions for programmable controllers (PLC) and PC-aided laboratory and industrial automation such as measuring and control engineering, material handling and management and different kind of followup tools.

Complementary services are documentation and illustrate to technical field.

For Whom ?

Sednove products and services meet the needs of industry and service companies. The company's know-how and products are used in several fields such as: energy production, machine industry and electric power plants.

How ?

The knowhow and strength of Sednove is based on trained and obliging persons. In addition to this a versatile cooperation with innovative subdeliverers and experts expand the covering of the services offered.

Sednove have been established 1994. It's fresh and observant modes of working enable an efficient and serving cooperation with a competitive cost structure.

Managing director Raimo Lappi takes care of the real process of Sednove Oy Ltd. and financial manager Pentti Lappi takes care of the capital process.

Sednove means the way to operate on a new manner.

"Non nova, sed nove" i.e. not necessarily new matters but with a new innovation.