Creation of catalog of the equipment, materials and data processing of project model of three-dimensional configuration of spent fuel pool cooling system in a CAD ”Polynom”

***Abstract*—The object of the research and modeling is a cycle of development of three-dimensional model of Spent Fuel Pool Cooling System. (SFPCS) The goal of the work is development of three-dimensional model of arrangement of the SFPCS. This article discusses a question of organization of data in a multi-functional CAD systems; methodology of constructing the model on the basis of organized by catalog of equipment and parts; life cycle the project model industrial facility; generating of reporting data based on of the project model. During the work executed PC Setup to optimize CAD ”POLYNOM”of the work performed testing program and modification of the program, resulting in improved performance. Result of the work is developed by the three-dimensional model of SFPCS, piping, equipment and heating equipment catalog created on the basis CAD system ”POLYNOM”. CAD system ”POLYNOM”was introduced into trial operation and developed by the the 3D model and a catalog of the equipment used for the design of of similar facilities.**

Keywords*—*EQUIPMENT CATALOG, DATA PROCESSING, PROJECT MODEL, CAD ”POLYNOM”, SPENT FUEL POOL COOLING SYSTEM, SFPCS, THREEDIMENSIONAL ARRANGEMENT, PARAMETRIC MODELING

I. Introduction

Building Information Modeling (BIM) is a revolutionary technology and process that has quickly transformed the way buildings are conceived, designed, constructed and operated. BIM is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle; defined as existing from earliest conception to demolition.

POLYNOM is a new generation of design systems created on the principle BIM that makes data the center of managing facilities for their entire lifecycles. The approach ensures that POLYNOM consistently works with 3D information models throughout all stages of the lifecycle: design, construction, operation, and decommissioning. This paper describes a question of organization of data in a multifunctional CAD systems; methodology of constructing the model on the basis organized by catalog equipment and parts; life cycle the project model industrial facility; generating reporting data based on the project model.

During the research executed PC Setup to optimize CAD ”POLYNOM”of the work performed testing program and modification of the program, resulting in improved performance. Result of the work is developed by the three-dimensional model of Spent Fuel Pool Cooling System, piping, equipment and heating equipment catalog created on the basis CAD system ”POLYNOM”. CAD system ”POLYNOM”was introduced into trial operation and developed by the the 3D model and a catalog of the equipment used for the design of of similar facilities.

II. Methodology

A. POLYNOM

POLYNOM is a new generation of 3D CAD for designing complex process facilities. It assists with construction, updates drawings from as-builts, and provides information models for operations and retrofits. POLYNOM was developed specifically for designing industrial facilities that contain millions of elements. It is based on NEOLANT's own state-of-the-art geometric 3D kernel, and so it handles engineering models representing the largest facilities, easily manipulating them on the screen. It works remotely over even low-speed communication connections. The approach ensures that POLYNOM consistently works with 3D information models throughout all stages of the lifecycle: design, construction, operation, and decommissioning.

POLYNOM supports the development of design documentation involving the following disciplines:

1) Production technology.
2) Metal structures.
3) Heating, ventilation, and air conditioning.
4) Water supply and sewage.
5) Architectural and construction concepts.

POLYNOM provides the tools and functions for designing processing facilities:

1) Process equipment and pipelines.
2) Architecture and construction elements.
3) Supports and suspenders.
4) Ventilation and heating.
5) Generation of drawings and specifications.
6) Operation with laser scanning point clouds.
7) 3D symbols designer.
8) Electric trays and cables.
9) Integration with calculating complexes.

B. Spent fuel pools

Spent fuel pools (SFP) are storage pools for spent fuel from nuclear reactors. They are typically 40 or more feet (12 m) deep, with the bottom 14 feet (4.3 m) equipped with storage racks designed to hold fuel assemblies removed from the reactor. A reactor's pool is specially designed for the reactor in which the fuel was used and situated at the reactor site. An away-from-reactor, Independent Spent Fuel Storage Installation (ISFSI), such as the one located at the Morris Operation, is also sometimes used. In many countries, the fuel assemblies, after being in the reactor for 3 to 6 years, are stored underwater for 10 to 20 years before being sent for reprocessing or dry cask storage. The water cools the fuel and provides shielding from radiation.

While only about 20 feet (6.1 m) of water is needed to keep radiation levels below acceptable levels, the extra depth provides a safety margin and allows fuel assemblies to be manipulated without special shielding to protect the operators.

C. Parametric modeling

Parametric modeling is a consistent set of principles for mathematical and computer modeling of three-dimensional solids. Solid modeling is distinguished from related areas of geometric modeling and computer graphics by its emphasis on physical fidelity. Together, the principles of geometric and solid modeling form the foundation of computer-aided design and in general support the creation, exchange, visualization, animation, and annotation of digital models of physical objects.

D. Pascal Script

Parametric equipment models were written on Pascal Script. A scripting engine in Pascal Script allows to customize an application taking into account their individual needs without having to recompile it. In addition, there is a possibility update applications by just sending a new script file that could even be compiled to byte code, which cannot easily be transformed back to source code.

Pascal Script includes the following features:

- Variables, Constants
- Standard language constructs:
- Begin/End
- If/Then/Else
- For/To/Downto/Do
- Case x Of
- Repeat/Until
- While
- Uses
- Exit
- Continue
- Break

Functions inside the script

- Calling any external DLL function (no special function headers required)
- Calling registered external methods
- All common types like Byte, Shortint, Char, Word, SmallInt, Cardinal, Longint, Integer, String, Real, Double, Single, Extended, Boolean, Array, Record, Enumerations, Variants
- Allows the importing and use of classes, with events, properties, methods and constructors
- Allows the importing and use of interfaces and their members
- Allows IDispatch dynamic method invocation through Variant
- Assignment of script functions to Delphi events
- Uses byte code as an intermediate format and allows the storing and reloading of compiled scripts
- Easy to use component version
- Support for include files
- Support for compiler defines
- Capability to call RemObjects SDK Services from within scripts
- Includes a tool to create headers for importing classes and interfaces

E. Testing

Testing is executing a system in order to identify any gaps, errors, or missing requirements in contrary to the actual requirements. Testing was conducted on a personal computer that has the following characteristics:

- Processor: Intel Core (TM) i5-2410M CPU @ 2,30GGts;
- The volume of RAM - 4 GB;
- Graphics cards - NVIDIA GeForce GT 520, Intel HD Graphics Family
- Hard Disk Drives - 97.5 GB, 14.5 GB of free hard disk space and 297 GB, 252 GB of free space.
- During the tests configured as follows software:
- Operating System: Microsoft Windows 7 Professional, SP1; CAD "POLYNOM" and Project Manager

III. Experiment

The Project Manager program was launched, in the table GATES new record is created, fields are filled: function, the name, the document, association type, control type, after confirmation of changes identification number is generated.

On a contribution "Designer" was the depressed key "Create the New Project", in the New Project window fields with use of the got earlier identification number are filled.

The character of a technological element, accessories or support shall be parametric. For communication of the character with the table the scripting insertion was added to the Character group in structure of the character.

The script was written:

```
QueryValues('select distinct V_D1,V_L,V_C1,VALVE_BODY from GATES where E_ID=:eid',[e_id],
'Var_D1,Var_L,Var_C1,var_VB_ID');
```

Fig.1. Script

Where, VarD1 - outer diameter, VarL - tie length, Var1 - height, varVID - type of connection.

The geometry from the elementary elements which overall dimensions are set by variables is created and are calculated automatically, depending on the data obtained from the table "GATES".

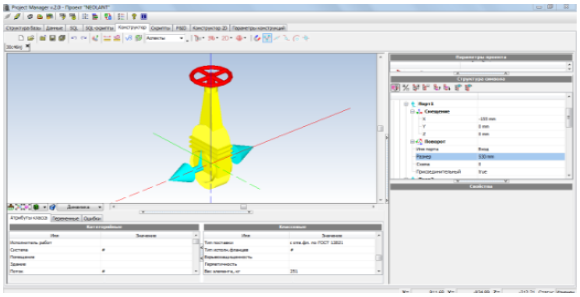

Fig.2. Process of creation of a gate

3 ports were added: Entrance, Exit (connecting) and Center (not connecting). In structure of a symbol the logical condition determining accession type was created. If it flange (its identification number 2), flanges are displayed, otherwise they will be hidden. Connecting ports are directed towards accession, not connecting up.

In the table "GATES", the new records corresponding to gates with various types of accession and overall dimensions were created. In the field of "SCRIPT" the way to the created script was specified. Summarizing, one may say, that latches have a feature of structure of a symbol: it is necessary to add a scripting insert for communication with the table and ports for accession to the available pipeline objects.

As a result of modeling the three-dimensional model of configuration of the cooling system of cooling ponds including architectural concepts and the equipment has been created. The created parametrical equipment, is added to the general catalog. Results of modeling are presented on fgures 3 and 4 :

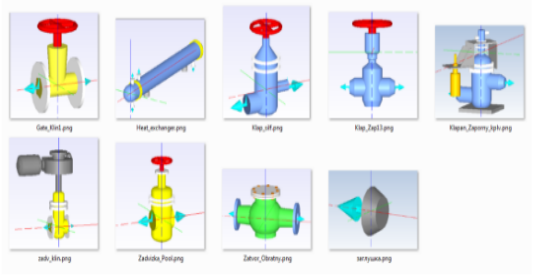

Fig.3. Equipment catalog

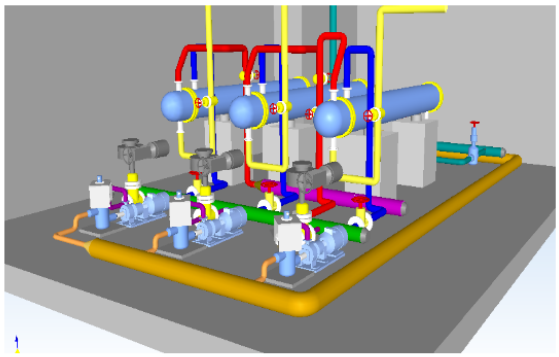

Fig.4. Piping heat exchangers

IV. Results and Discussion

The result of a research of steel carried out the analysis of data domain, questions of data structure in a CAD "POLYNOM" are considered; methodology of creation of model on the basis of the organized directory of the equipment and details; life cycle of project model of an industrial facility; reporting data on the basis of project model are generated.

In development process and modification of objects practical skills were received:

1) installations of a CAD "POLYNOM"
2) settings of the PCs parameters for the correct operation of a CAD "POLYNOMIAL"
3) adding of new users, operations as the user and the administrator
4) settings of the interface of the program
5) creations of objects of different type
6) writing of scripting insertions for parametrization of objects
7) operations with a model basis

Besides, the developed 3D model of the cooling system of cooling ponds and the directory of the parametric equipment created on the basis of a CAD "POLYNOM" is result.

V. Conclusion

During the research CAD "POLYNOM" a row of errors, a part from which managed to be eliminated with the PC setup, was revealed. Remaining errors are studied. There is a search of ways of their elimination.

The CAD "POLYNOMIAL" is implemented into trial operation, and the developed 3D model and the directory of the equipment can be used for design of similar objects.

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