SPM SYSTEM

# System of monitoring, managing and operating submersible pumps and deep-water intakes

ENERGY SAVING SYSTEM

SYSTEM DESCRIPTION

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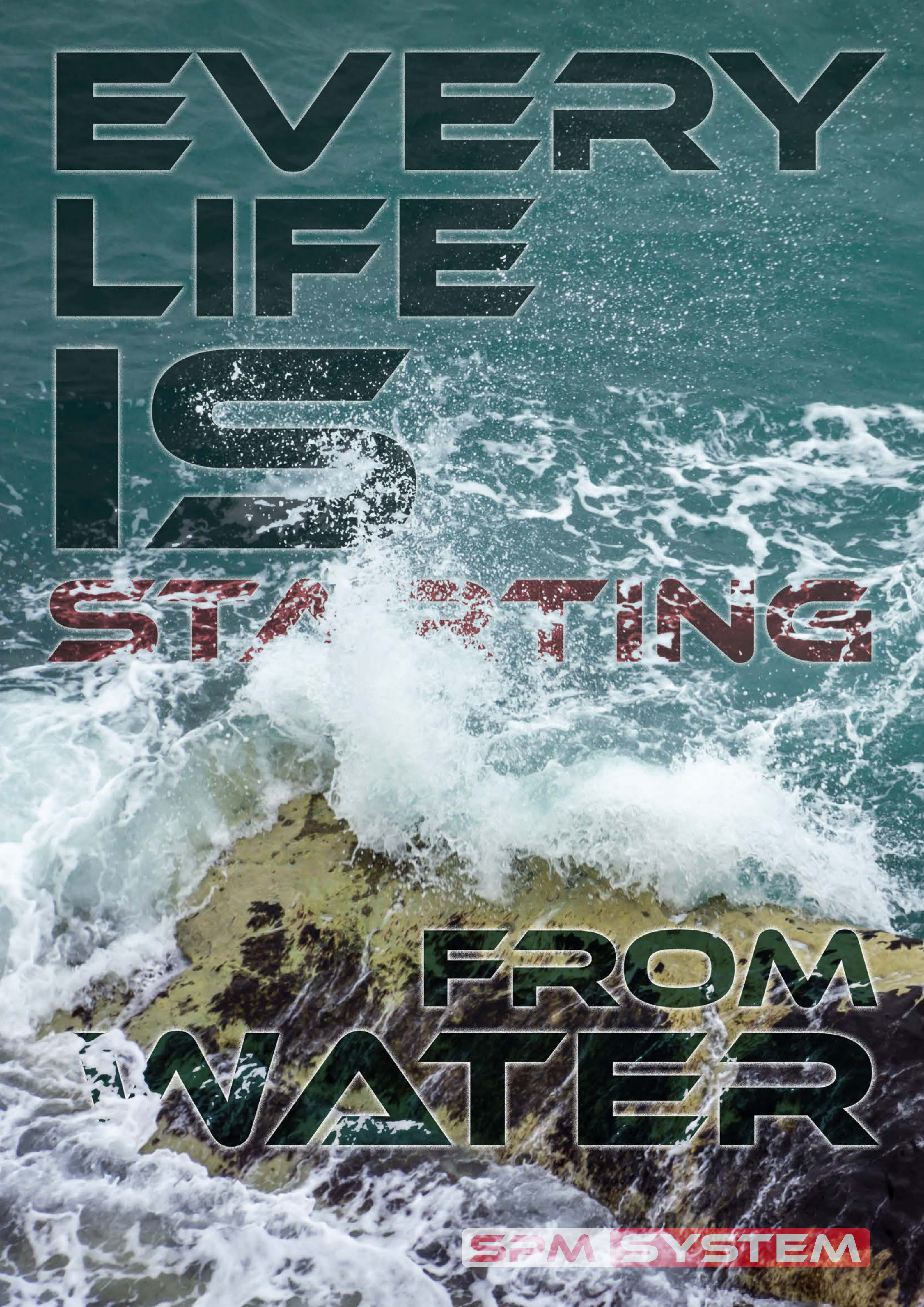

EVERY
LIFE
IS
STARTING
FROM
WATER
SPM SYSTEM

# SYSTEM OF MONITORING, MANAGING AND OPERATING SUBMERSIBLE PUMPS AND DEEP-WATER INTAKES

The implementation of digital systems and devices without prior preparation of an information system may result in a disorderly acceleration of the circulation of certain groups of information while not being able to process them properly. At the same time, there may be a lack of key groups of information that are necessary for the proper work of mathematical models.

## 1. DIGITAL TECHNOLOGY IN PUMP OPERATING SYSTEMS

The use of digital technology in the operation of pumps is inherently associated with the functioning of complex IT systems, whose task is to acquire, transmit, collect and process significant amounts of data and information, and often also to control the operation of complex pump systems along with their diagnostics. Speaking about the implementation of digital technology, we mean the use of systems and devices functioning with its use – computer systems and programs, measurement systems, digital data transmission systems, automation systems and devices, and control systems.

The correct implementation of digital technology in pump operation systems requires taking into account many issues related to system technology, pump technology, hydrogeology, treatment technology, electrical engineering and automation – Figure 1.

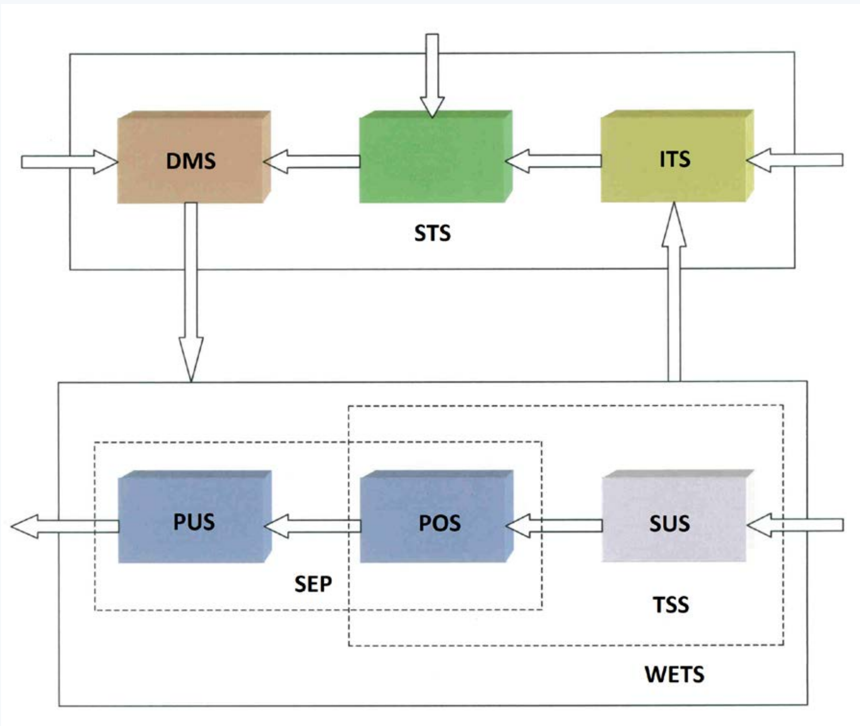



**Figure 1**

Speaking about the use of digital technology in the operation of pumps, we must be aware that this technique should be implemented in the POS (pump operation system) as well as in every system cooperating with it – TSS (technical support system), WETS (water extraction and transmission system), ITS (information system), and DMS (decision-making system).

The key link in this respect is the construction and functioning of the ITS (information system), which brings together the entire circulation and structure of information flow occurring in the POS (pump operation system) as well as in the TSS (technical support system). This system also receives information from the outside. After collecting and processing the information, the system directs their ordered packages to the DMS (decision-making system) where decisions are made regarding the functioning of the POS (pump operation system) and the TSS (technical support system). What is important in the STS (steering system) – DMS (decision-making system) is supported by the active work of mathematical models that mainly optimize electricity consumption and conduct parametric and technical diagnostics of pump systems.

The scope and amount of information that must be obtained and processed in the ITS (information system), usually needs to be organized and systematized.

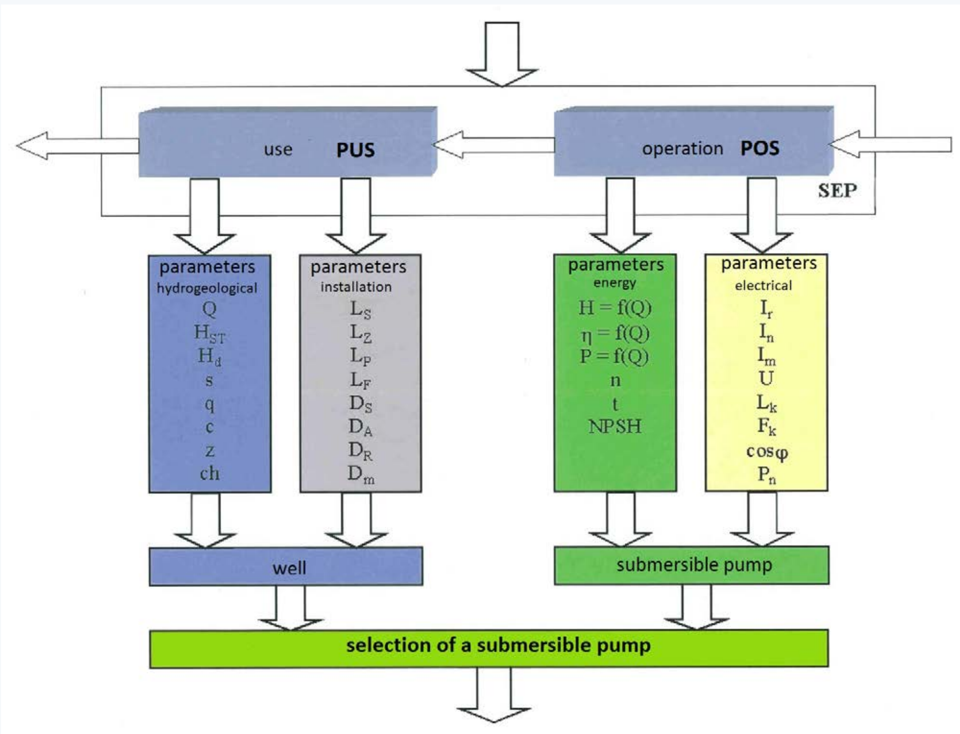



**Figure 2**

Figure 2 shows an example of amount of information to be processed in order to correctly select the pump for the deep well pump system.

Figure 3 shows in a simplified way a diagram of the flow of information from operational data to ready-made reports and decisions.

It is clear that the quality of the system is determined by:

- completeness and quality of operational data,
- method of data transmission and access,

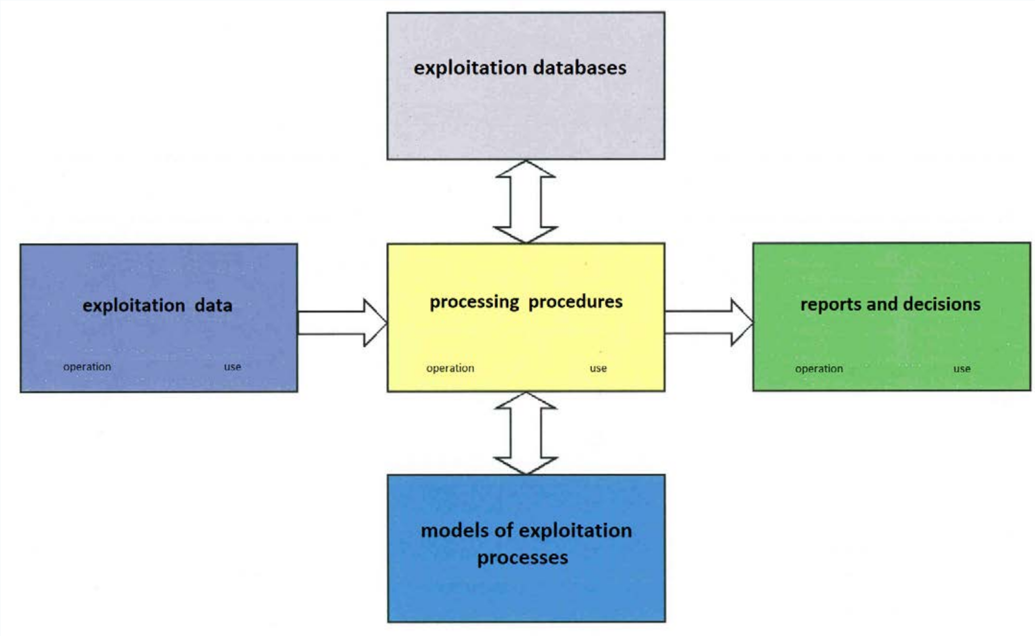



**Figure 3**

- the size of the operational databases,
- the scope of information processing procedures,
- the quantity and quality of mathematical models reflecting the exploitation processes.

It must be stated that in the near future, development in the field of building information systems will be aimed at enriching models simulating exploitation processes and increasing use of the Internet for remote access to the software and its control, e.g. via GSM and SAT networks. For example, there is already a Cloud applied in controlling the operation of deep-water intakes – **SPM**$_{\mathbf{SYSTEM}}$.

The main purpose of using digital systems and devices in the pump operation system and its surroundings is to improve the operation of the information system, and consequently to improve the quality of decisions and increase the efficiency of operation. The assumption is that after organizing and accelerating the flow of information, it will be possible to operate optimally the pumps.

Before implementing digital systems and devices, it is necessary to prepare and adapt the information system guided by the principle: only the necessary amounts of information and only when it is needed. It should also be remembered that the effectiveness of operation is determined by the quality of information processing (mainly in relation to mathematical models), not their quantity and visualization.

Leaving the system operator with a flood of transmitted information – often visualized, without the possibility of model processing to generate decisions – is a system error and in this case, it is difficult to talk about the correct use of digital technology in the operation of pumps.

It must be remembered that digital technology is to serve pump technology, not vice versa!

The implementation of digital systems and devices in the operation of pumps usually takes place on 3 levels:

1. use of only such computer programs in which all information occurring in the pump operating system and its surroundings is collected and processed,
2. the use of computer programs in which operational information data is collected, processed and visualized, along with remote control of pump operation,
3. the use of local and remote control of the pump systems operation, which is controlled and synchronized by the information system.

There may be cases of individual configurations of system and device applications, e.g. level 1, 3, etc.

## 2. SYSTEM MANAGEMENT, INTERACTIVE MONITORING AND CONTROL OF SUBMERSIBLE PUMPS OPERATIONS

Before implementing digital technology in the operation of pumps, it is imperative to carry out a thorough analysis of the real needs and objectives of its use both on the side of the functioning of the pump operation system itself and on the part of potentially applicable digital devices and systems. The idea is to avoid disturbing the „system balance" between *systems technology – pump technology – digital technology*. The number and type of applied digital systems and devices must correspond to the real technological needs in the pump operating system and in its surroundings.

Monitoring of pump system is usually a component of monitoring and controlling of the technological process of either the Waterworks or Mining Company. Starting from intake wells, through centrifugal or submersible pump systems, measurement data and system status signals should correspond to the scope of their processing as well as the operational needs of the service.

Measurements from wells and from pump systems go to a computer program in which they are collected, processed and selected measurements are visualized on the monitor screen of e.g. the system operator of the Waterworks Company. Some of the data is processed with support of the mathematical models and the results of computer analysis together with statistics of pump systems operations additionally support taking the right operational decisions.

Nowadays, a classic, exemplary system of management, monitoring and control of submersible and centrifugal pumps is **SPM$_{\mathbf{SYSTEM}}$** (Figure 4). This system is intended to contribute to the energy-efficient operations of pumps and submersible intakes.

Figure 4 shows the structure of the system for a unit adapted to manage the operations of pumping systems in a well.

A similarly built blocks manage the operations of centrifugal or submersible pumps. Monitoring and controlling of the submersible pump systems is more complex than similar requirements for centrifugal pumps. As can be seen from Figure 4, the structure of the **SPM$_{\mathbf{SYSTEM}}$** construction includes 2 basic elements:

- 4 versions of dedicated **SoftSPM** software,
- 4 sets of **SPM** instrumentation and metering


**Figure 4**

In **SPM$_{\text{SYSTEM}}$**, modularly expandable levels of **SoftSPM** software are mutually compatible with sets of **SPM** instrumentation and metering of wells and thus allow any configuration of the system by any user. **SPM$_{\text{SYSTEM}}$** can be optimally configured for the user of several, or several dozen, or several hundred, or even several thousand of wells, regardless of whether they will be intake wells or, for example, drainage wells. The scope of the system includes:

- software:
  - SoftSPM$_{\text{BASIC}}$ – systems of up to several wells,
  - SoftSPM$_{\text{STANDARD}}$ – systems of several dozen up to several hundred wells,
  - SoftSPM$_{\text{ENTERPRISE}}$ – systems of several thousand wells (corporations),
  - SoftSPM$_{\text{TEST}}$ – test stations of pump units.
- Instrumentation and metering of wells:
  - SPM$_{\text{MIN}}$ – minimum range of well metering
  - SPM$_{\text{BASE}}$ – the most commonly used well metering range
  - SPM$_{\text{OPT}}$ – extensive well metering range
  - SPM$_{\text{TEST}}$ – test station instrumentation

## 2.1. Information technology in the management of submersible pump operations

For example, Figure 5 shows a structural diagram of the simplest version of **the SoftSPM$_{\text{BASIC}}$** software, which is the basic level for the most common pumps and submersible intake systems. Figure 6 shows a diagram of **the SoftSPM$_{\text{ENTERPRISE}}$** software designed for users of large exploitation systems – even more than a thousand wells, most often operated by corporations. Data obtained directly from the pump use system, the steering system, the technical support system, and the environment are taken into account and the information is orderly organized. **SoftSPM** software is a web application, in other words it is a computer program that works on servers, and communication with the end user takes place through the Internet, using web browsers.

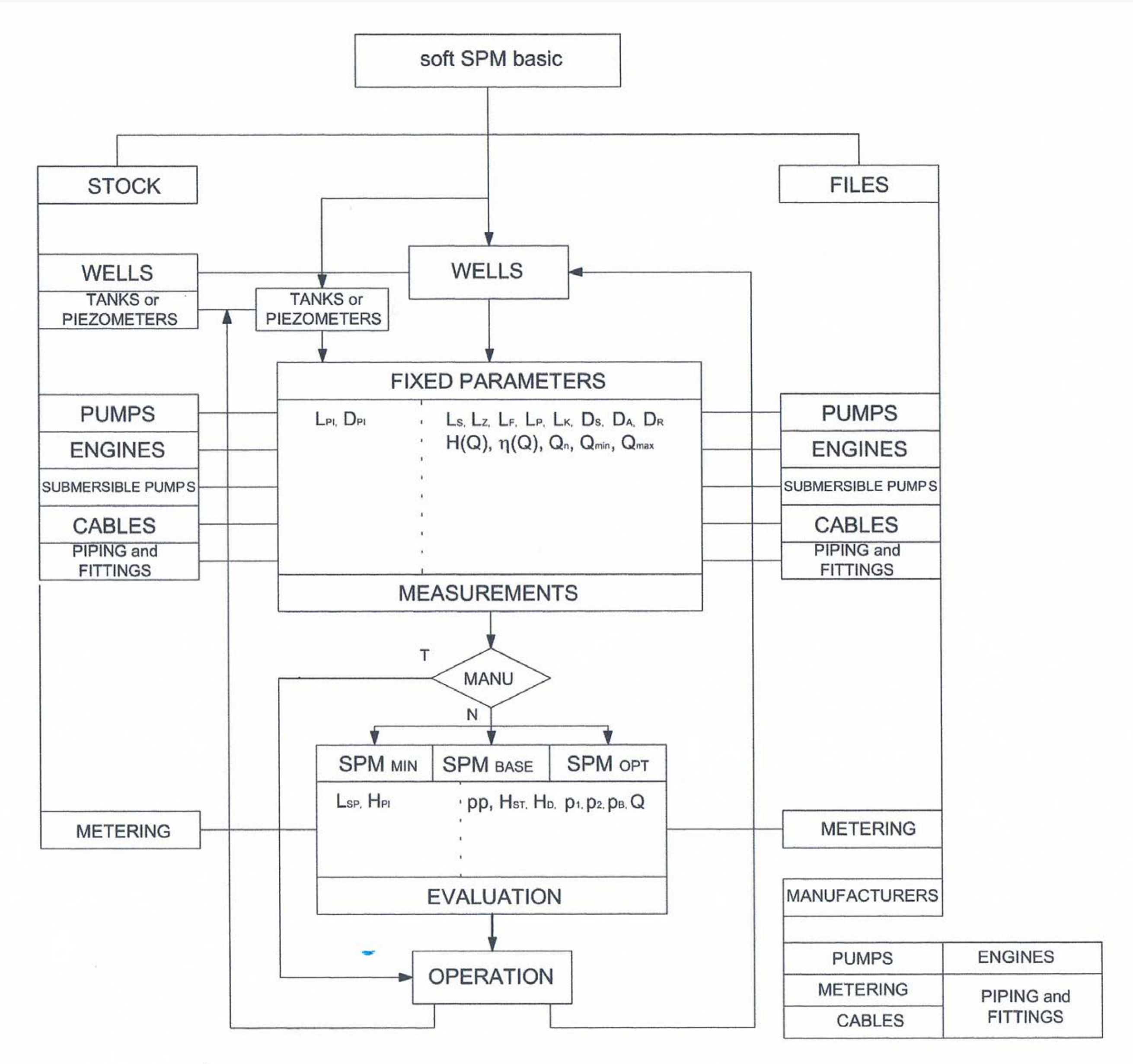
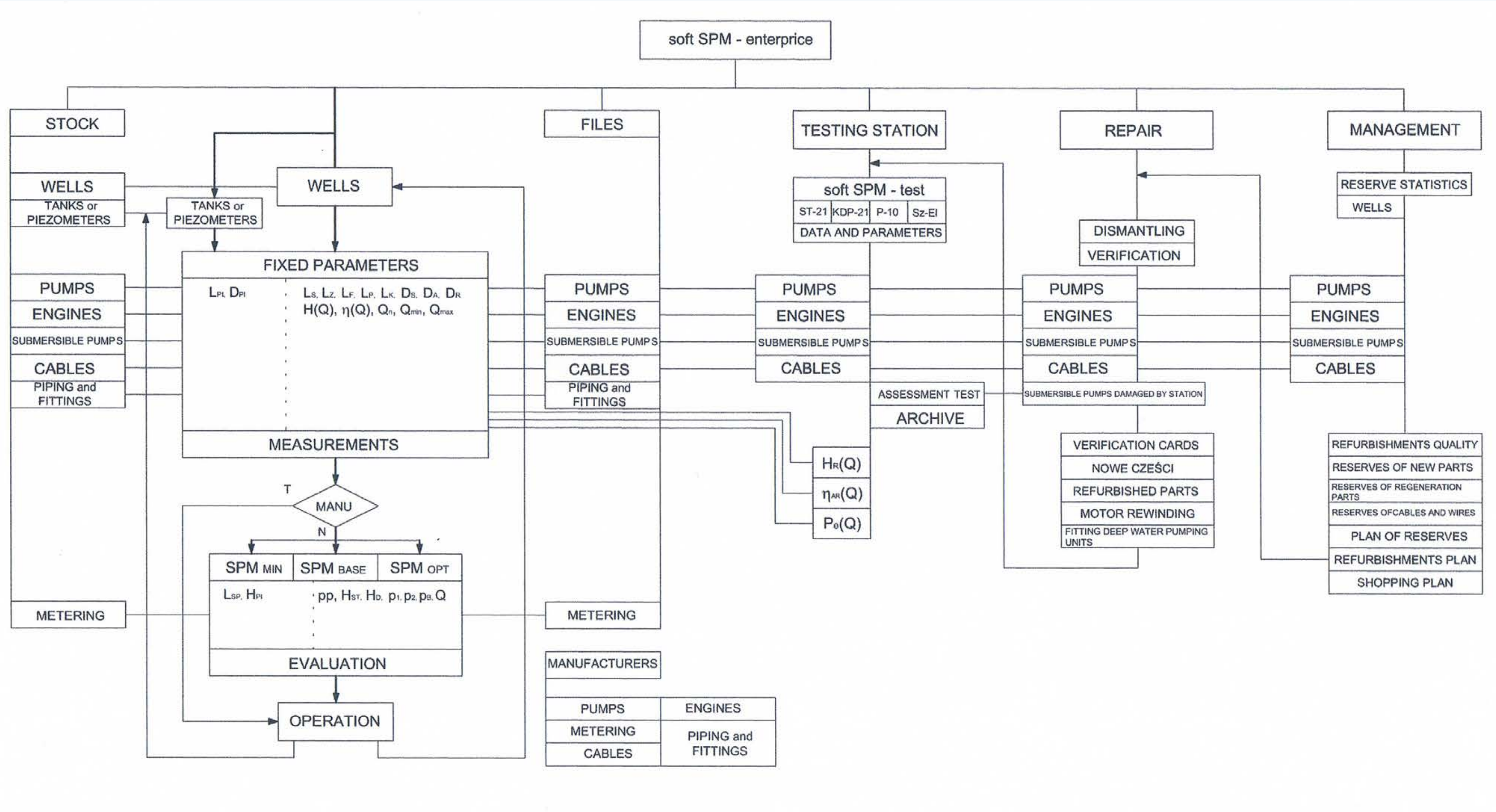



**Figure 5**



soft SPM - enterprice
STOCK
WELLS
TANKS or PIEZOMETERS
PUMPS
ENGINES
SUBMERSIBLE PUMPS
CABLES
PIPING and FITTINGS
METERING
TANKS or PIEZOMETERS
WELLS
FIXED PARAMETERS
MEASUREMENTS
MANU
T
N
SPM MIN
SPM BASE
SPM OPT
EVALUATION
OPERATION
FILES
PUMPS
ENGINES
SUBMERSIBLE PUMPS
CABLES
PIPING and FITTINGS
METERING
MANUFACTURERS
PUMPS
ENGINES
METERING
PIPING and FITTINGS
CABLES
TESTING STATION
soft SPM - test
ST-21
KDP-21
P-10
Sz-El
DATA AND PARAMETERS
PUMPS
ENGINES
SUBMERSIBLE PUMPS
CABLES
ASSESSMENT TEST
ARCHIVE
REPAIR
DISMANTLING
VERIFICATION
PUMPS
ENGINES
SUBMERSIBLE PUMPS
CABLES
SUBMERSIBLE PUMPS DAMAGED BY STATION
VERIFICATION CARDS
NOWE CZĘŚCI
REFURBISHED PARTS
MOTOR REWINDING
FITTING DEEP WATER PUMPING UNITS
MANAGEMENT
RESERVE STATISTICS
WELLS
PUMPS
ENGINES
SUBMERSIBLE PUMPS
CABLES
REFURBISHMENTS QUALITY
RESERVES OF NEW PARTS
RESERVES OF REGENERATION PARTS
RESERVES OFCABLES AND WIRES
PLAN OF RESERVES
REFURBISHMENTS PLAN
SHOPPING PLAN


**Figure 6**

The software has been developed in such a way that its appearance and layout automatically adapt to the size of the window of the device on which it is displayed (PCs, smartphones, tablets). In addition, the software meets expectations in the context of „user experience design", i.e. an interactive product with particular attention to the providing users with a positive experience, which directly translates into its operational intuitiveness.

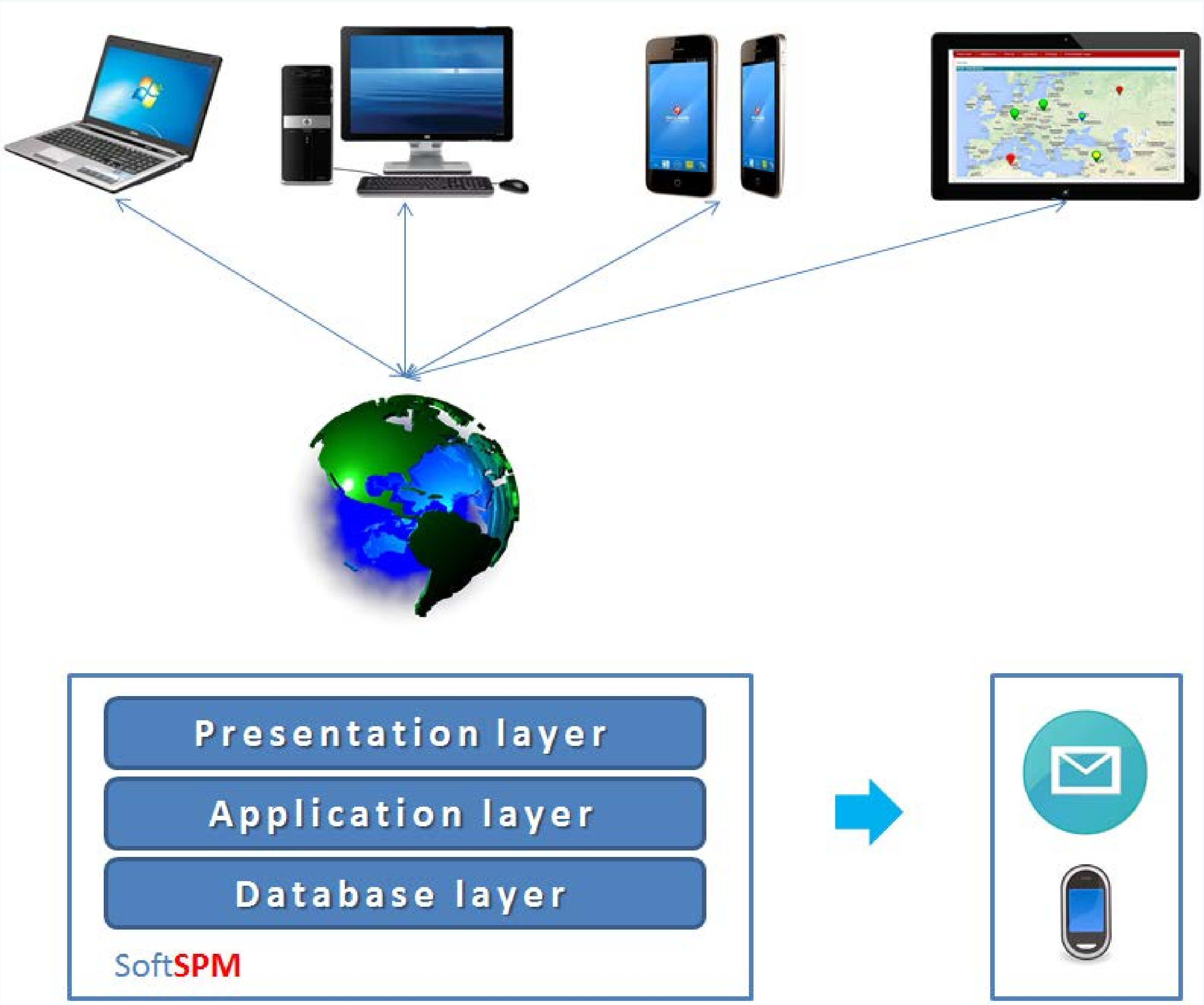



**Figure 7**

**SoftSPM** software is built on the basis of a three-layer architecture (Figure 7), which includes a database server, an application server, and a presentation server. Application of the latest Open-Source solutions translates directly into total costs of system implementation – the user does not incur additional expenses for the purchase of 3$^{rd}$ party commercial software (application servers, database servers).

The wireless and reliable technologies used for communication between **SoftSPM** software and dedicated SPM system metering instrumentation mounted at the facilities help to avoid limitations related to the distance or territorial barriers. It can certainly be said that in each of its variants the system is able to handle any device – even thousands of kilometers away from the

**SoftSPM** server. By leveraging the possibilities of using the application via the Internet, pump system management becomes simple, functional and accessible at anytime from anywhere in the world.

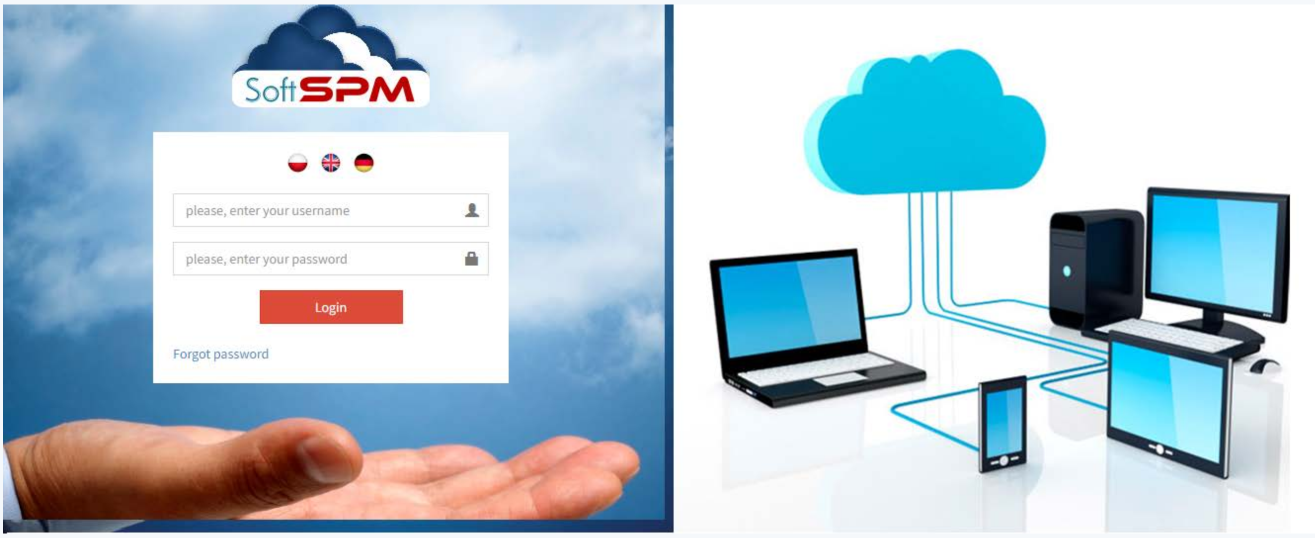



**Figure 8**

Nowadays, the version of the so-called **SPM$_{\mathbf{SYSTEM}}$** Cloud is preferred, which allows the user to access software located on a foreign server as part of subscription fees (Figure 8).

The test station **SoftSPM$_{\mathbf{TEST}}$** software was created as a desktop application, i.e. installed on a computer connected directly to the test station of the pumping station and to the Internet. Measurement data from **the SoftSPM$_{\mathbf{TEST}}$** system are available within the entire **SPM$_{\mathbf{SYSTEM}}$** (in all its versions) immediately after the test.

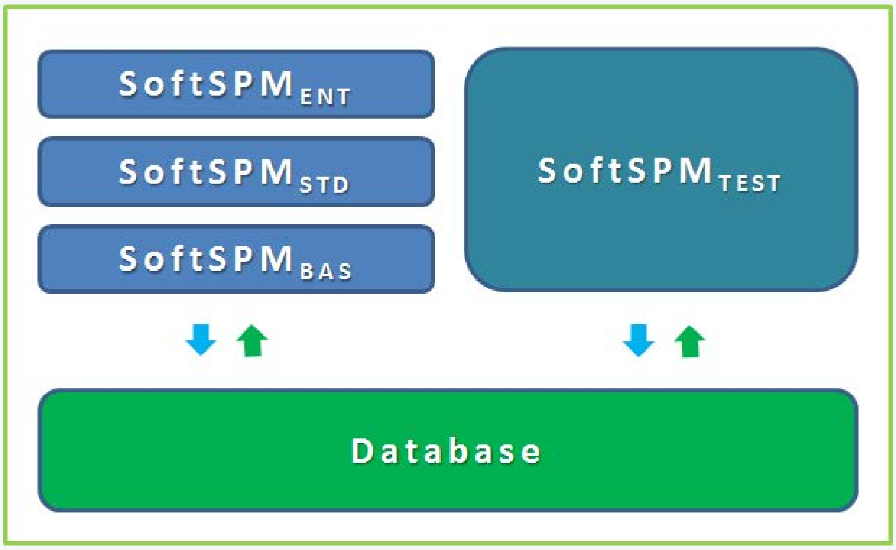



**Figure 9**

Figure 9 shows the localization structure of **SoftSPM$_{\mathbf{TEST}}$** software in a **SoftSPM** environment.

## 2.2. Dedicated versions of instrumentation and metering of pump systems

As mentioned, **SPM$_{SYSTEM}$** has three versions of well instrumentation and metering – **SPM$_{MIN}$**, **SPM$_{BASE}$** and **SPM$_{OPT}$**. Each of these versions is based on the latest, dedicated solutions in the field of metering of well pump systems, which include, among others, a patented, integrated pressure measurement probe inside and outside the discharge pipeline of the submersible pump, mounted behind the pump discharge connection, under water. This probe allows to determine precisely the balance of flow losses in the pump system, including the determination of linear flow losses in the pipeline on which the submersible pump operates. Based on the measured pressure values inside and outside of the discharge pipeline of the submersible pump just behind its discharge connection under water, the mathematical models of the system enable precise mapping of the position of the operating point of the submersible pump on its characteristics $H = f(Q)$, and thus diagnose the current technical condition of the operating pump and the submersible motor. The exact pressure balance in the pump system enables precise power accounting in the system, including the value spent on the operation of the geohydraulics of the well.

Figure 10 shows a diagram of equipment installation and metering for the „base" version of well instrumentation and metering – **SPM$_{BASE}$**.

In this version, the following parameters are measured in the pump system:

- well measurements:
  - $p_p$ pressure at the discharge connection of the submersible pump (under water),
  - the position of the static or dynamic water level $H_{ST}$, $H_D$ in the well,
  - pressure $p_1$, $p_2$ (before and after the valve),
  - pump capacity $Q$,
- electrical measurements:
  - rated voltage $U$,
  - power consumption $I$,
  - active power consumption $P_e$,
  - power factor cos Ø,
  - current diagnostics.
- remote control:
  - switching on/off the pump motor.

A binary signal is also transmitted from each object (well), generated in the event of interference by unauthorized persons (the so-called object protection signal).

The **SPM$_{BASE}$** version is the most commonly used in the operation of water intakes and this version ensures high accuracy of measurements of hydraulic parameters in the pump system – measurement class below 0.5.

Each version of **the SoftSPM** software is based on the latest, dedicated solutions in the field of metering of the pump systems of **SPM** wells.

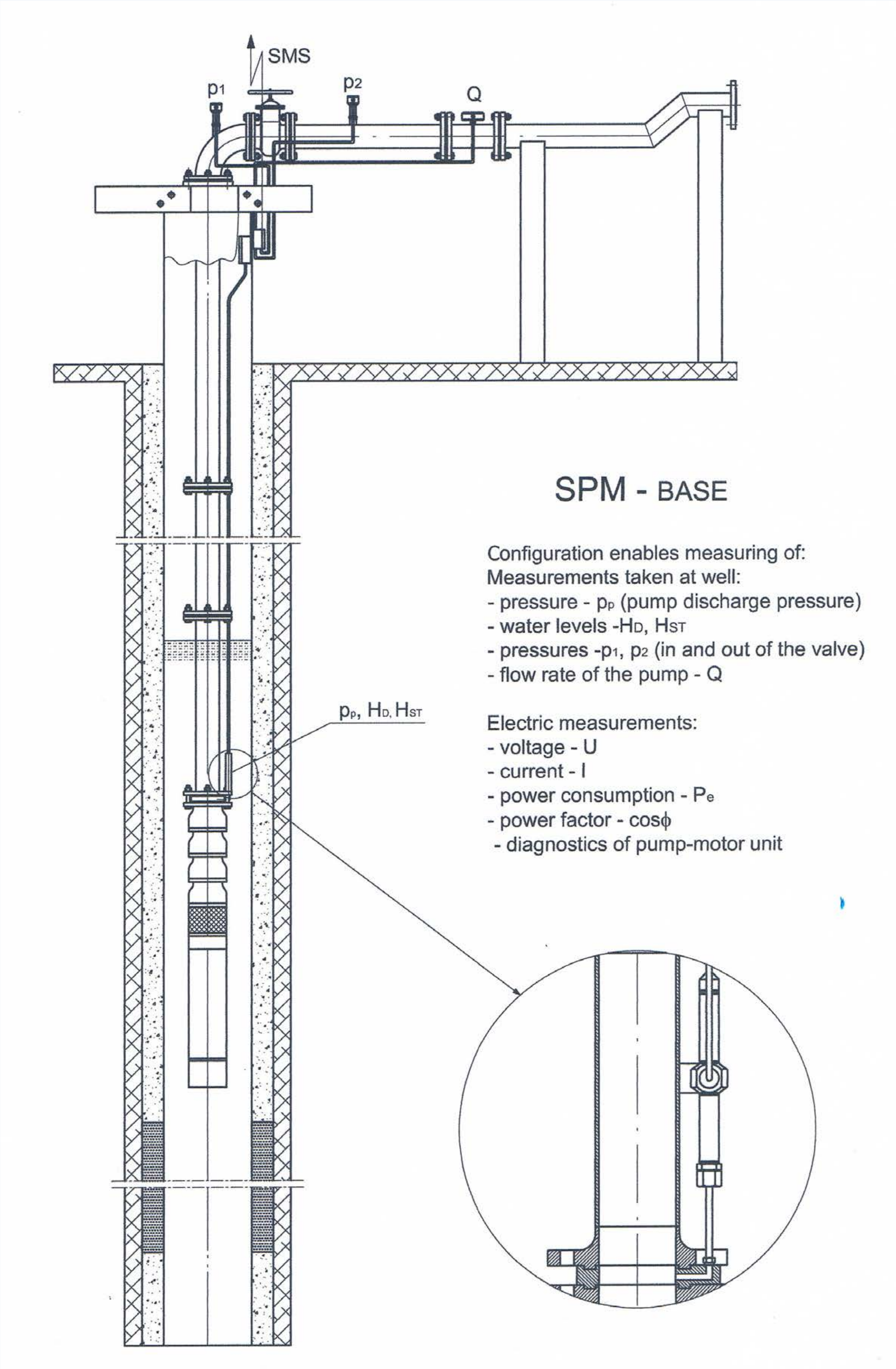

SMS
$p_1$
$p_2$
Q
SPM - BASE
Configuration enables measuring of:
Measurements taken at well:
- pressure - $p_p$ (pump discharge pressure)
- water levels -$H_D$, $H_{ST}$
- pressures -$p_1$, $p_2$ (in and out of the valve)
- flow rate of the pump - Q
$p_p$, $H_D$, $H_{ST}$
Electric measurements:
- voltage - U
- current - I
- power consumption - $P_e$
- power factor - $\cos\phi$
- diagnostics of pump-motor unit

**Figure 10**

## 2.3. Functioning of the system

In **SPM$_{\textbf{SYSTEM}}$**, the management of the operation of pumps and submersible intakes is carried out from the applied version of **SoftSPM** software, which is configured in such a way that already at the stage of the first insight into the operation of the system, i.e. on the aggregated map, you can read the results of assessments of the operation of the objects and their current state of operation.

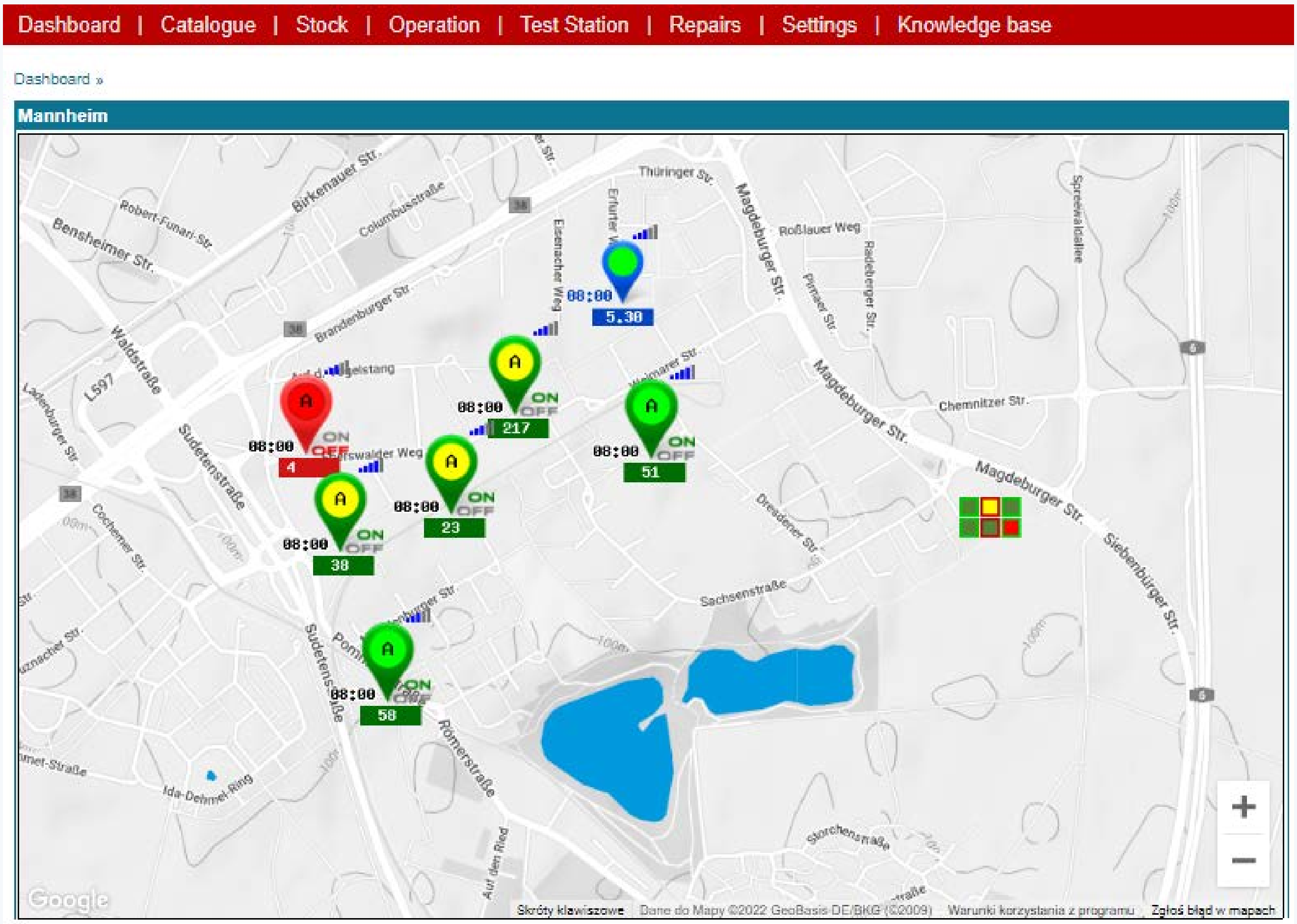



**Figure 11**

This task is carried out in such a way that the location of the well is presented in the form of the so-called „teardrop" (Figure 11), whose color indicates the state of operation of the well: green color means ongoing operation of the submersible pump while the red color indicates the shutdown of the pump unit. The location of the centrifugal pumping station is illustrated by a set of squares.

The status of switching on the submersible pump is also confirmed by the inscription **ON** or **OFF**. In addition, the internal color of the circle in the "teardrop" indicates the result of the assessment of the energy consumption of the submersible pump system with a reference to the following principle:

- green indicates optimal operation,
- yellow indicates work in the breakeven area,
- red indicates unprofitable operation.

To reflect the control modes of the well operations the letter is included inside the circle: **A** – for work in an automatic mode, and **R** – for a manual operations mode.

The map (Figure 11) also shows the location of the tanks. The location of the tanks is also marked in the form of a „teardrop" but it is blue in color. The color of the inner circle indicates the current filling status of the tank divided into:

- green color means optimal filling of the tank,
- yellow indicates the close to critical value of water level,
- red indicates the alarm level of water in the tank.

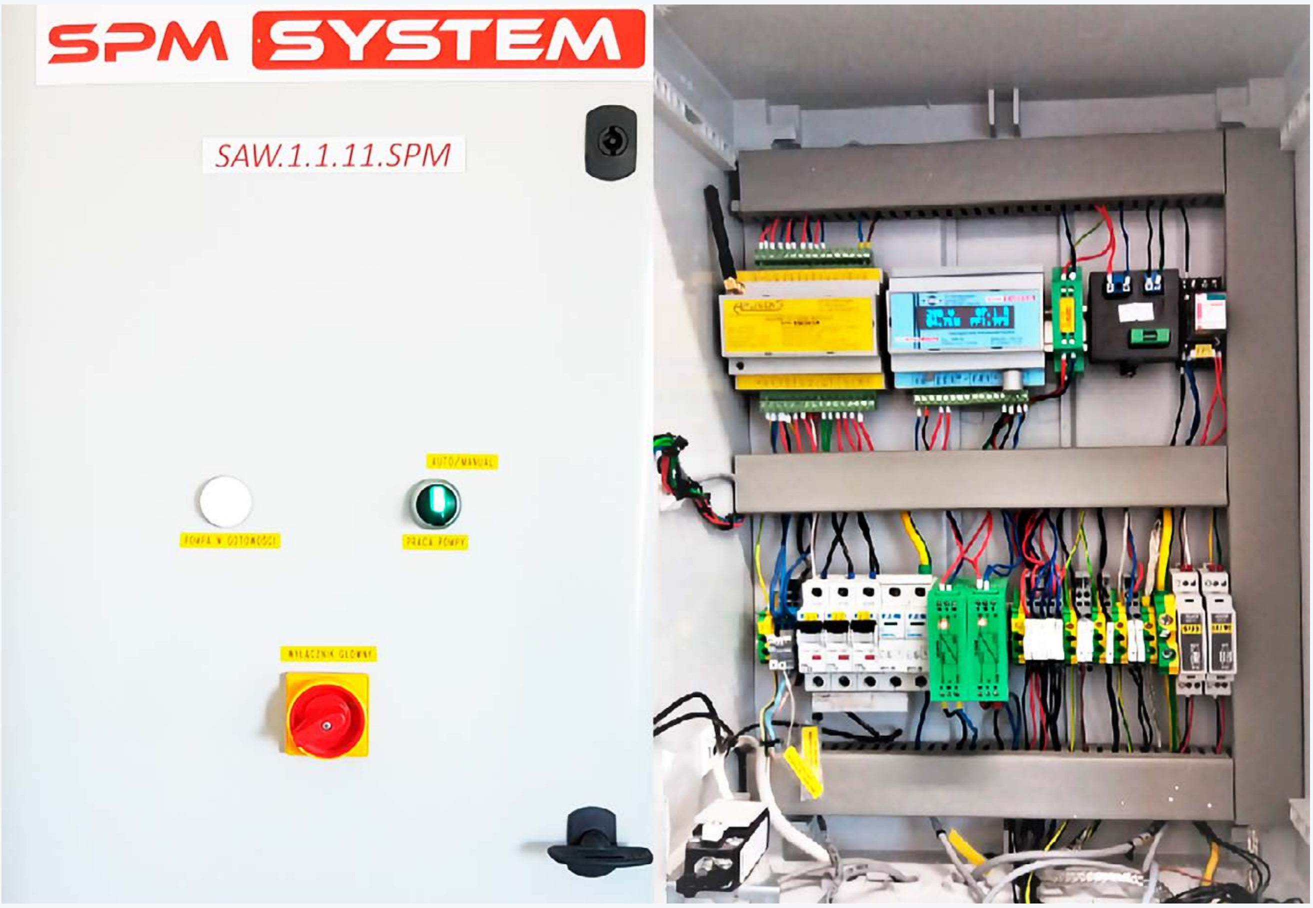



**Figure 12**

Figure 12 shows a system automation cabinet located next to objects, from which control and monitoring of the operations of objects is carried out.

Figure 13 shows a visualization of the centrifugal pumping station operation with an indication of the operating status of individual pump stations.

In addition, for a quick analysis under the „tear" of the well in the rectangle (with the same color of the pump operating status), the current value of the pump capacity is given, and just above it the time when measurement was taken. For the tank, the value of the water level is given in the same way.

Practically after the first look at the map showing the objects, the user quickly knows about the status of the operations of the system. In the event of alarm related to the operations of


**Figure 13**

pumps and tanks – appropriate markings and descriptions in red are appearing on the map. To illustrate the GSM signal strength at the location points of the objects, appropriate indications reflecting these values are visualized.

After clicking on the selected object – well, the user „enters” a deeper layer of operations analysis reflecting the results of mathematical models assessing the current operation of the pump system of the well or centrifugal unit (Figure 14 and Figure 15).

Visualization of the results of the analysis carried out in mathematical models of evaluations of the operation of the pump system is mapped in the central and lower parts of the screen. Assessment is carried out by computer on the basis of current values of hydraulic and electrical parameters transferred to **the SoftSPM** software from **SPM** instrumentation and metering.

Mathematic models of assessments take into account:

- location of the operating point of the submersible pump in the pre-designated (in the model) range of optimal operation,
- current deformation of the characteristics $H = f(Q)$ of the pump operated in the pump system along with diagnostics of the leak-proofness of the discharge pipeline,
- the value of current degree of throttling of the flow in the valve of the pump system,
- the value of precisely determined linear losses in the pump discharge pipeline,
- the current level of energy consumption of the pump system,
- the state of energy quality of geohydraulics of the well.

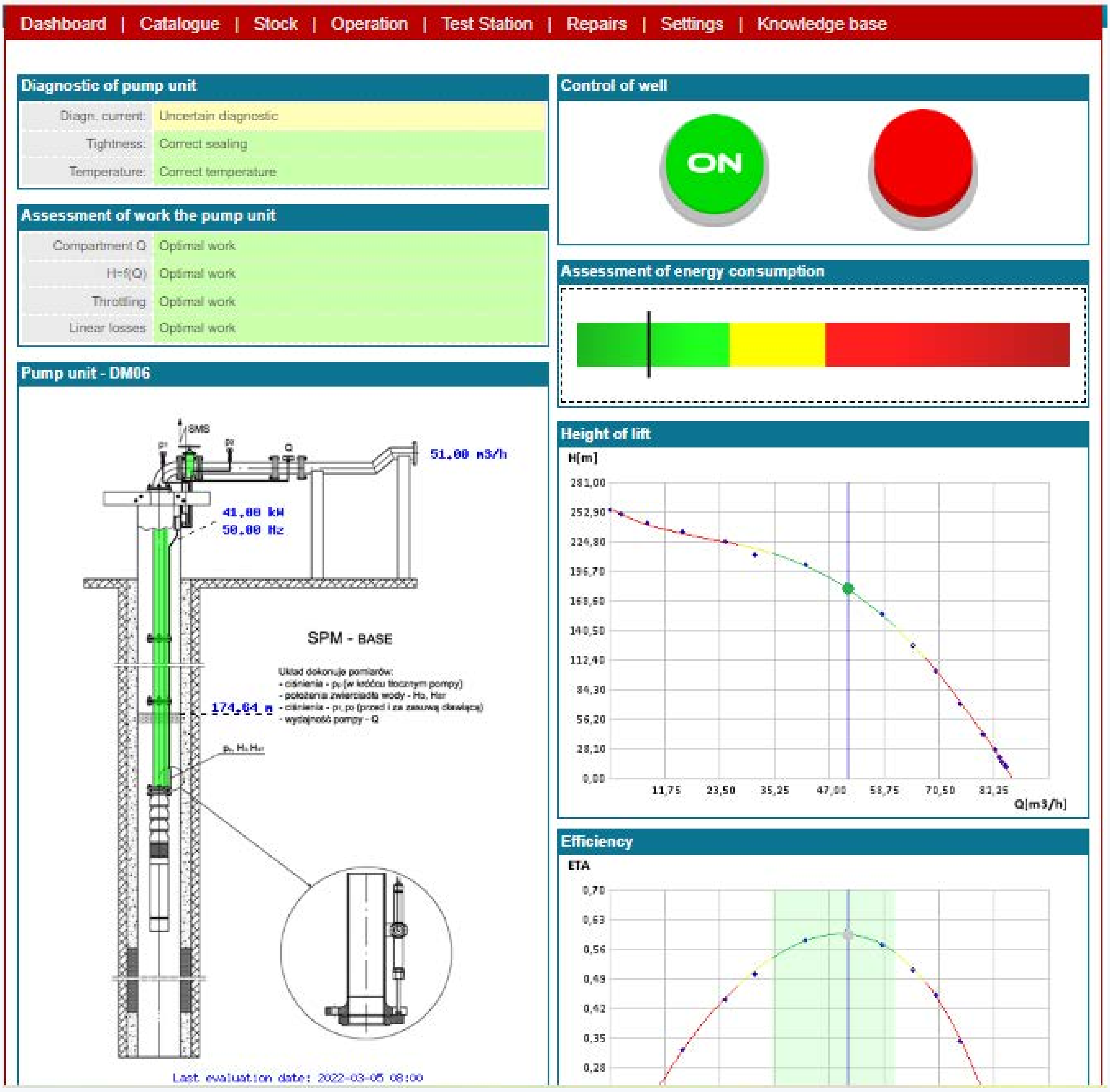



**Figure 14**

Based on the assessment criteria encoded in mathematical models, taking into account systemic, mutual parametric dependencies and some of their time-varying waveforms, the evaluation program compiles results for individual, current sets of measurements of the objects. The results are presented in text and graphic form. Background colors of the evaluation text fields indicate their ranges following the principle:

- green indicates optimal operations,
- yellow indicates work in the break-even area,
- red indicates unprofitable operation.

Figure 16 and Figure 17 shows examples of evaluations of the submersible and centrifugal pump system. You can clearly see the range of changes in the pump system, including the so-called energy consumption bar.

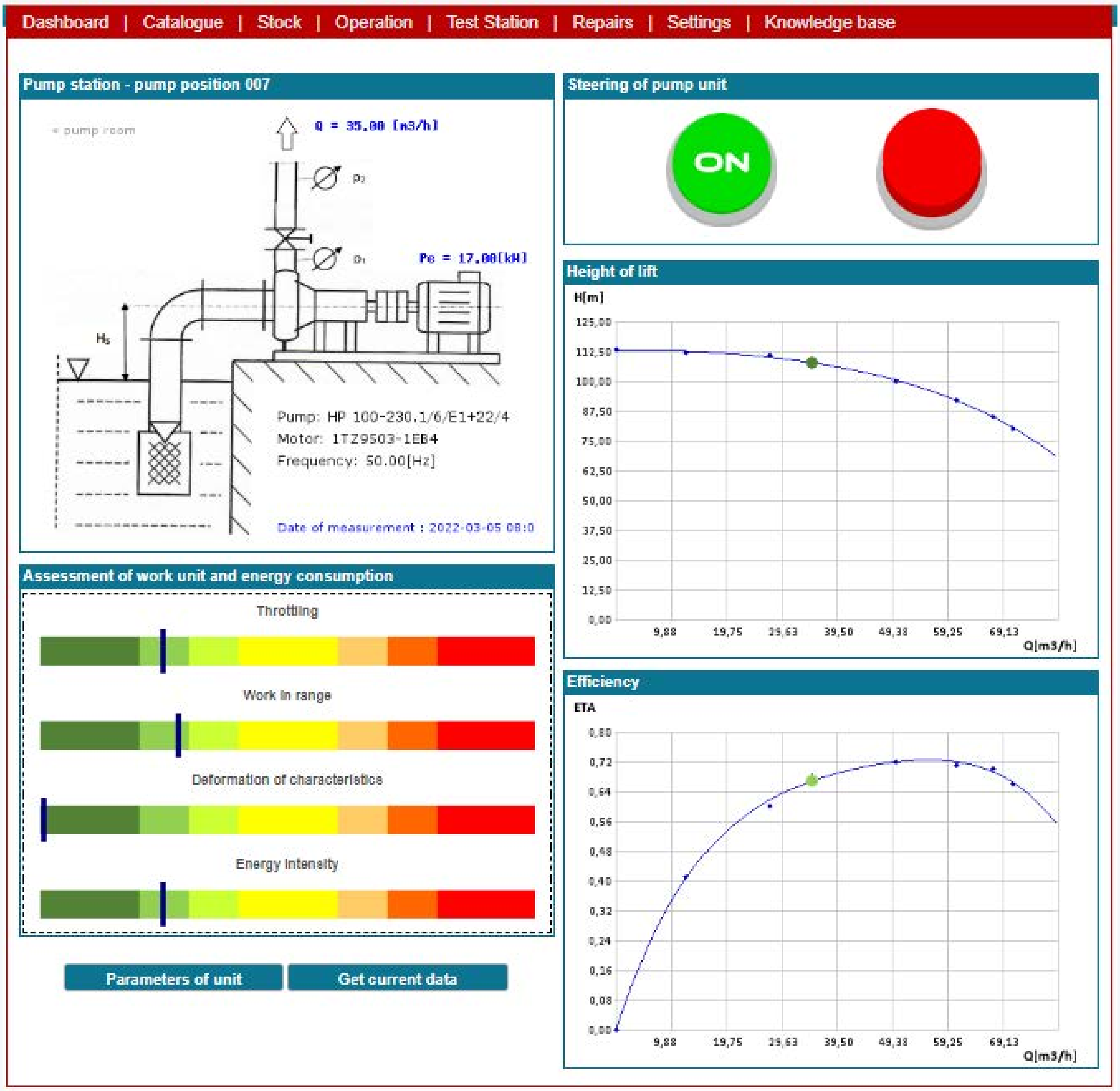



**Figure 15**

Figure 18 shows a graphic visualization, reproducing color of the place of assessment on the diagram of the construction of the pump system. The color of the discharge pipeline and throttle indicates the result of the assessment for these elements of the system. This diagram also shows the value of the current pump capacity and the current position of the water level in the well and the measurement time.

The assessment of the degree of deformation of the *H* = *f*(*Q*) characteristic is visualized by the color of the indicated pump operating point (Figure 19). As in the previous cases, the colors of the grades – green, yellow and red indicate respectively: optimal work, the beginning of deformation of the characteristics and deformed characteristics. In each of these cases, information is also given about the possible loss of leak-proofness of the pump discharge pipeline. Figure 19 shows the assessment of the degree of deformation of the *H* = *f*(*Q*) characteristics, and the assessment of the position of the pump operating point against the range of optimal pump ap-

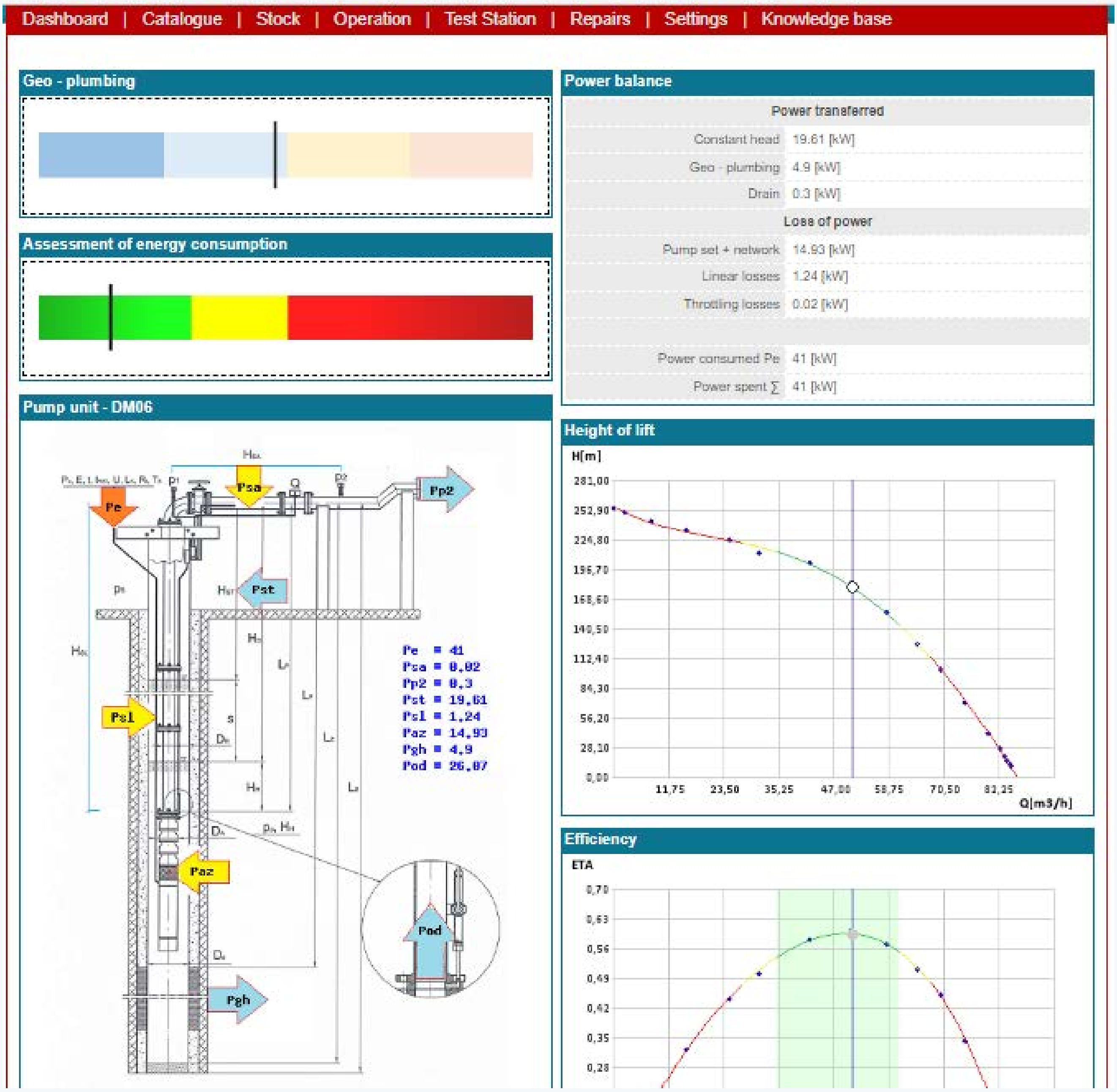



**Figure 16**

plicability. As it can be seen, the pump works within the optimal range of the applicability range and has already deformed characteristics.

According to the principle adopted in the system – if you want to get acquainted with a more accurate assessment, click on the object of interest and „enter" into a deeper layer of analysis reflecting the exact location of the working point against the background of the actual characteristics of the pump from the test station (Figure 20).

A point in blue shows the actual lifting height of the pump for a given capacity, which is the actual location of the work point on the new, already changed characteristics. The mathematical model's analysis of the actual deformation of the characteristics uses pressure measurements made by an integrated probe mounted behind the discharge connection of the submersible pump. The method of diagnosing the submersible pump and the pump system using the inte-

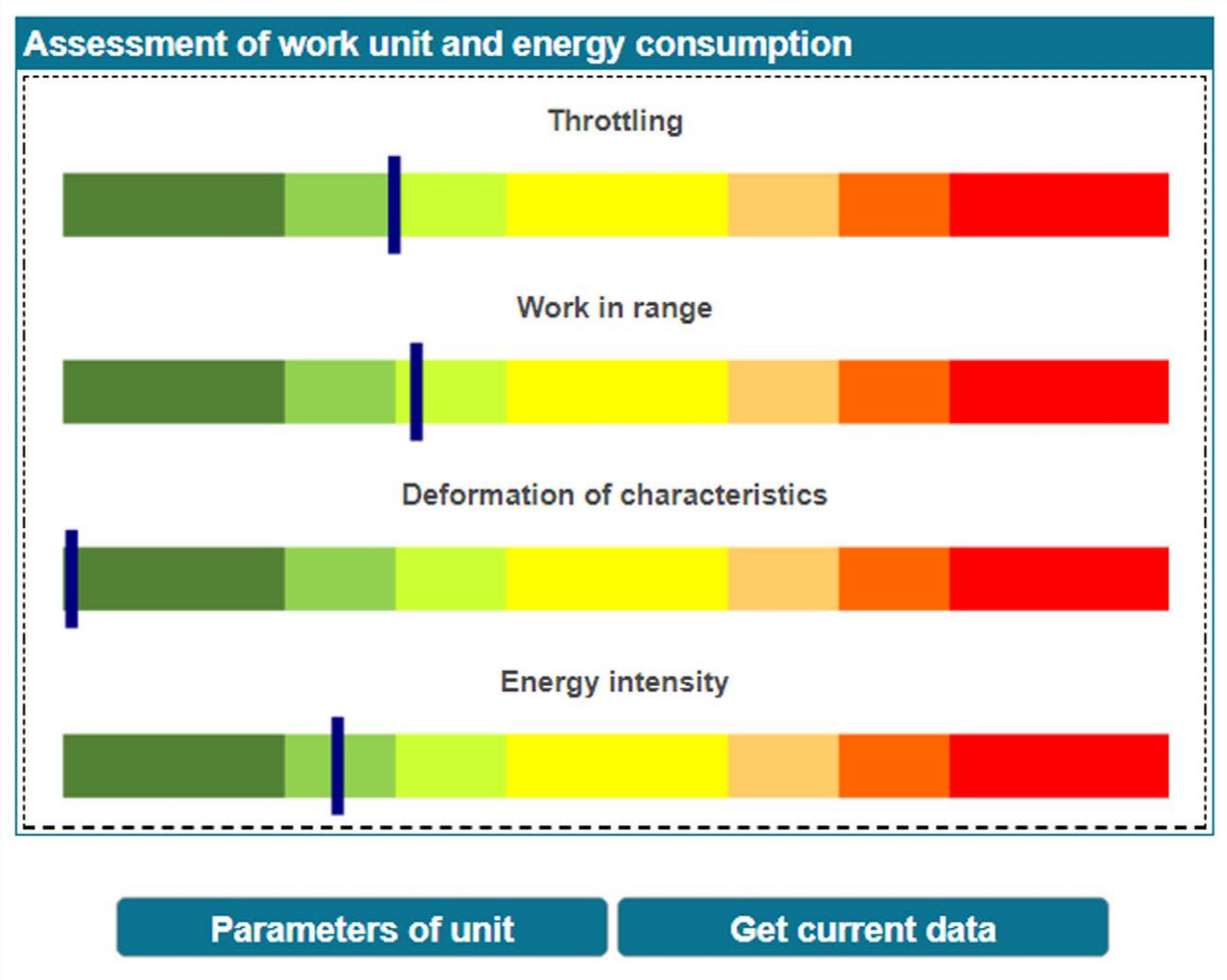



**Figure 17**

grated pressure measurement probe is currently the latest, patented way to assess the operating status of the submersible pump together with the entire system. In the upper part of the evaluation screen there are control panels for the operation of the submersible pump unit, switch on/off the pump motor or e.g. the position of the throttle (Figure 21).

By clicking "Parameters of unit" button on the rating screen (Figure 14), the user „enters" into detailed summaries of data and parameters of the system and the well (Figure 22).

The data and operating parameters of the pump system and the well practically include a set of both information about the type of pump and submersible motor along with serial numbers and data from the test protocol of the aggregate at the station as well as data related to the well. The date of installation of the pump unit in the pump system of the well is given, along with a full set of installation data. Data from the well opening card are also presented, starting from the date of execution of the well, through the results of test pumping to a set of operating parameters from the current operation of the pump. The electrical parameters of a submersible motor operations are also included.

Figure 23 shows a view of the screen reflecting operation of the tank supplying the water supply network. The degree of filling of the tank is graphically depicted and the locations of the warning and alarm levels are marked. The values of the location of these levels are given next

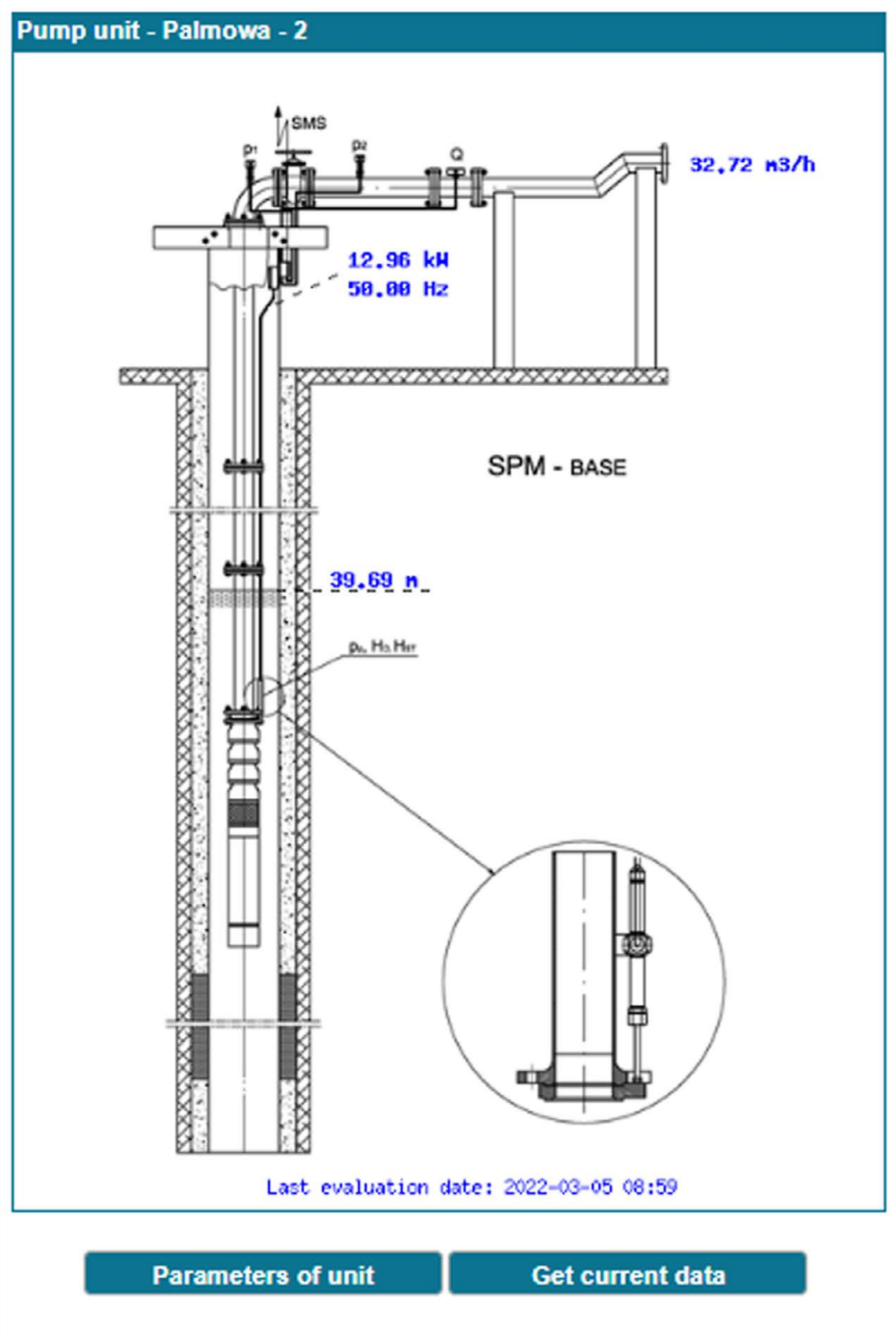

Pump unit - Palmowa - 2
SMS
Q
32,72 m3/h
12.96 kW
50.00 Hz
SPM - BASE
39.69 m
Last evaluation date: 2022-03-05 08:59
Parameters of unit
Get current data

**Figure 18**

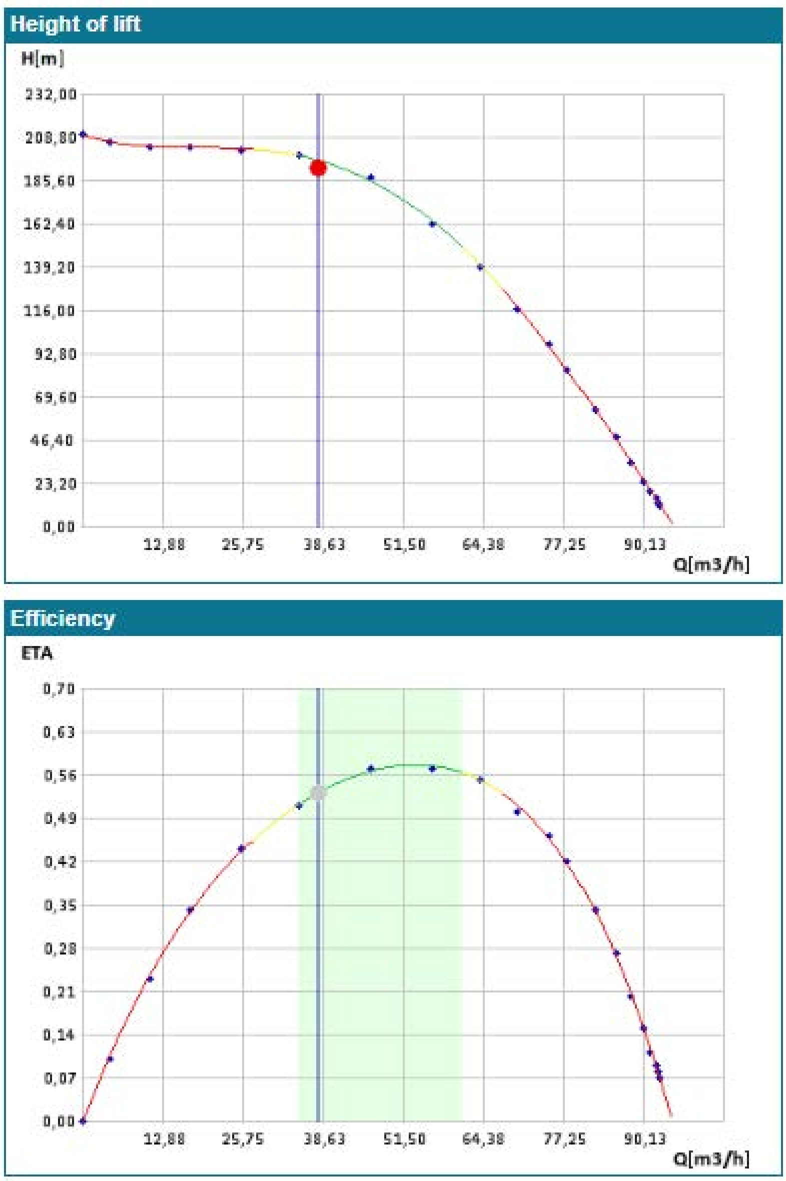



**Figure 19**

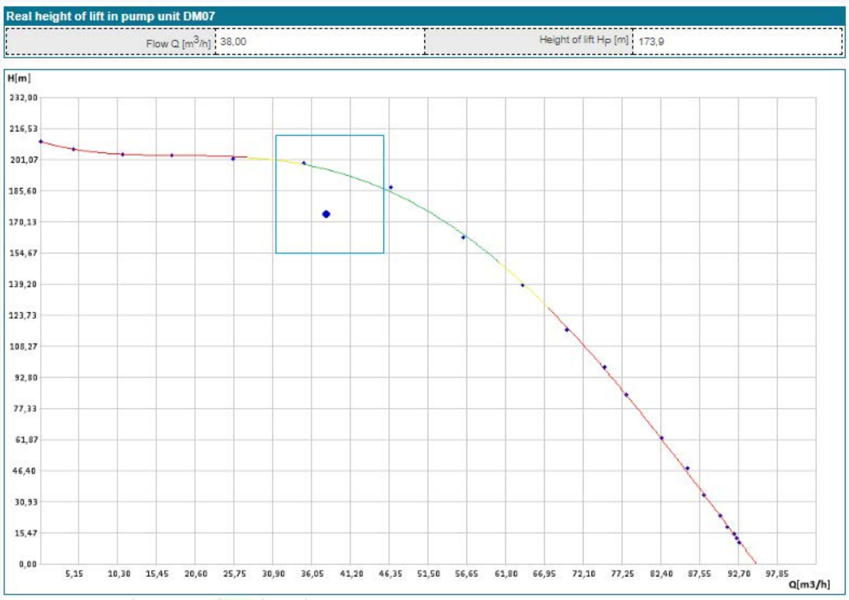



**Figure 20**

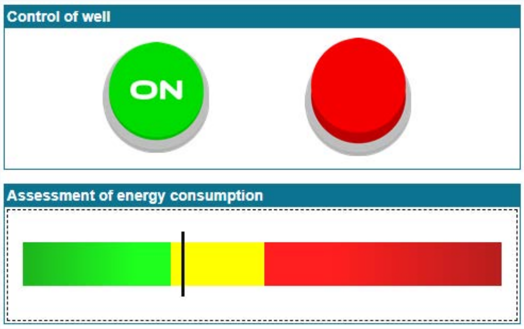



Figure 21

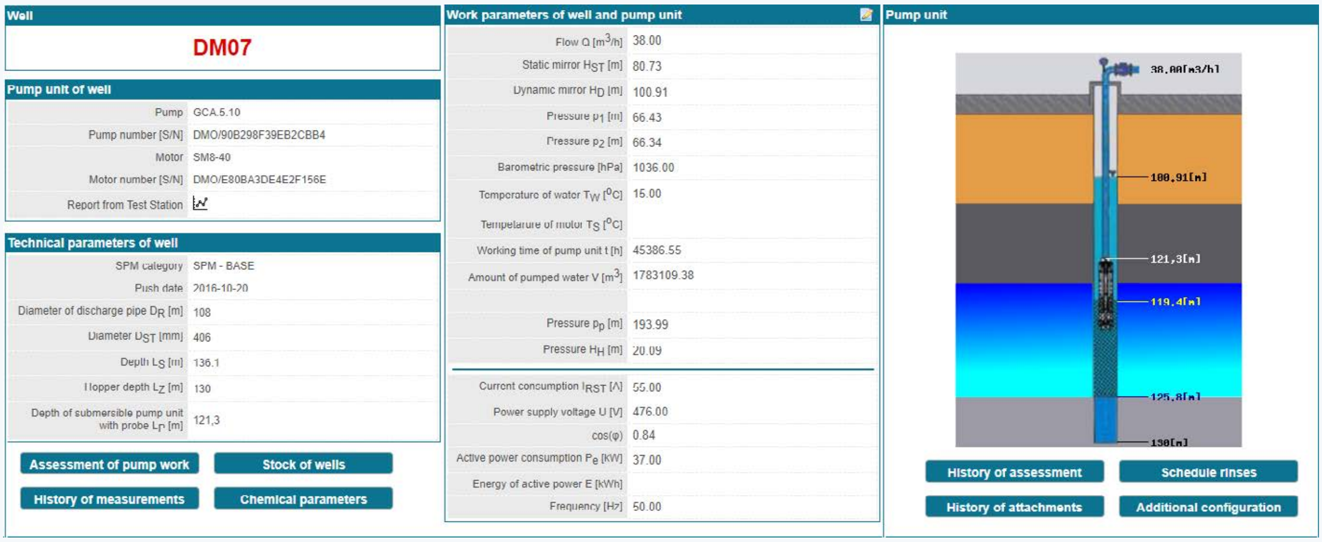



Figure 22

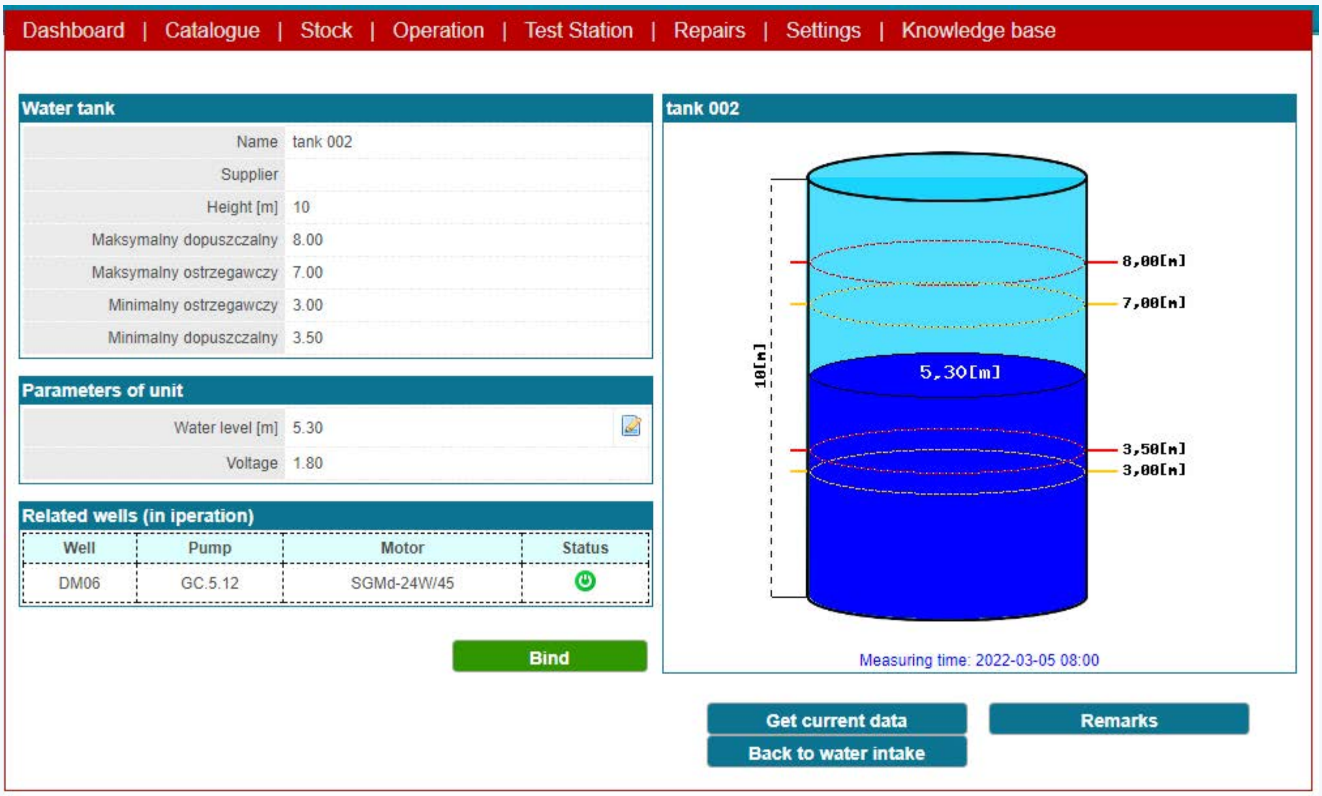



Figure 23

to the tank view, while in the lower part of the screen information about the wells feeding water to the tank is given and it is marked whether these wells are currently working or not.

In the **SoftSPM** software, you can practically freely configure the modes of controlling the operation of water intakes or centrifugal pumps according to ready-made or user-configured **SPM$_{\mathbf{SYSTEM}}$** algorithms.

## 2.4. Remote data transmission and pump control

Taking into account modern technologies dealing with remote control and digital data transmission, **SPM$_{\mathbf{SYSTEM}}$** uses mainly wide range of GSM networks – and potentially also satellite communication. For communication between objects (**SZ-21** tank, **SZ-21.z** well, **SoftSPM** software), a short text message service (so-called **SMS**) in digital mobile networks is used. For high reliability, any **SMS** that is sent as a data source (from any „object") is confirmed by a return **SMS** from the objects to which it was sent. In the absence of this two-way communication, an alarm/notification appears with complete information about its type and cause.

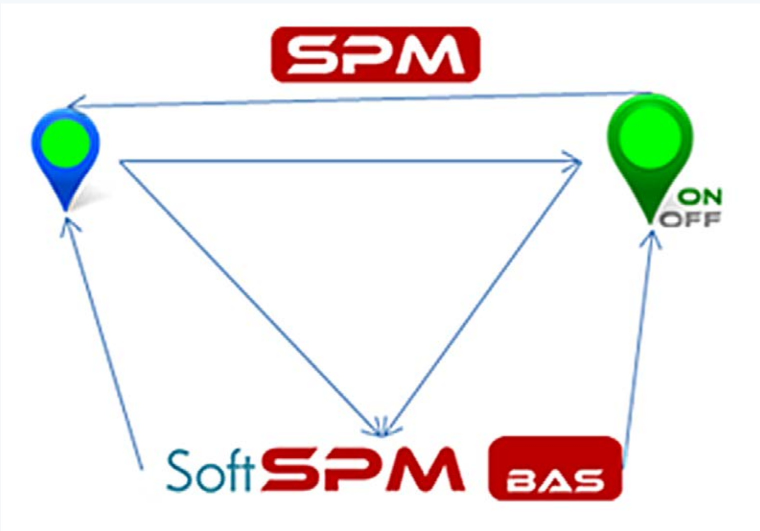



**Figure 24**

Figure 24 shows an example of a communication scheme in controlling and informing about status of the operations of **SPM$_{\mathbf{SYSTEM}}$**. In fact, any GSM network can be used, and therefore potential use of antennas that amplify network coverage levels, for communication in **SMS** technology, the control and data transmission capabilities have been significantly expanded. Before the implementation of the system, appropriate network coverage measurements are carried out. The system operates in „distributed" technology. Specialized controllers of the **SZ-21** and **SIMATIC S7 1200** system have been configured in such a way that the control and data transmission technologies work mainly via **SMS**. This (encrypted) configuration, in addition to quick operation with poor network coverage, significantly reduces the cost of maintaining the system, and thus affects the operating costs of the entire system. It is understandable that local driver software requires more extensive and complex algorithms, which ensure constant, substantive supervision of the object. Practically, the driver sends **SMS** only when such an event occurs, which requires a reaction from a „higher level" program, located on the user's server or on a public server, e.g. https://cloud.softspm.com. The described structure of the construction and technology of the **SoftSPM** software practically does not distinguish the distance from the server to a given object and in addition, the time of „reaching” the **SMS** from and to the server is in a maximum period of a few seconds, so the reaction from the „higher level” program is practically immediate. It is similar in the case when we turn on or off the pump motor via the server or remotely change the settings of other parameters – e.g. inverter frequency, throttle position, etc. **SPM$_{SYSTEM}$** in its knowledge base and in the construction of complex mathematical models concentrates a number of precise procedures for dealing with predictable operating states of pump systems. Over time, these databases systematically grow, and thus, the system itself optimizes the operation of individual work algorithms. If the user has any number of wells and many tanks connected by an extensive network of pipelines, the **SoftSPM** system software allows to configure virtually any control structure for objects within the range of the GSM network. When the objects are clearly located outside the GSM range, the system configuration selects other access media, e.g. radio, cables, fiber optics, or ultimately satellite communication.

## 3. SCOPE OF DATA AND INFORMATION PROCESSED

According to the assumptions in **SPM$_{SYSTEM}$,** the scope of processed data and information is extremely wide and in practice includes:

- pumping technology:
  - computer catalogue of submersible pump units with selection and choice of pumps,
  - automatically controlled submersible pump test stations,
  - visualization of pump operating points on their characteristics $H = f(Q)$ during operation (catalog characteristics or from test stations),
  - evaluation of pump operations according to the catalog and real characteristics.
- drilling technique and hydrogeology:
  - computer catalog of drainage wells and piezometers,
  - database of operating wells and piezometers,
  - database of water chemistry,
- electrical engineering:
  - computer catalog of submersible motors,
  - database of operating submersible motors,
  - database of electrical equipment and cables,
  - power and control and measuring cabinets with devices,
- computer technology:
  - **SoftSPM** software:
    - » **SoftSPM$_{BASIC}$**
      - Starter package:
        - Water intake performance statistics,
        - Assessment,
        - Catalogues of pumps, motors, cables, tooling and fittings.
    - » **SoftSPM$_{STANDARD}$**
      - Starter package:
        - Water intake performance statistics,

        - Assessment,
        - Catalogues of pumps, motors, cables, instrumentation and fittings,
        - Test stations of submersible pump units.
- **SoftSPM$_{\textbf{ENTERPRISE}}$**
    - Starter package:
        - Water intake performance statistics,
        - Assessment,
        - Catalogues of pumps, motors, cables, instrumentation and fittings,
        - Test stations of submersible pump units,
        - Maintenance package of pumps and submersible motors,
        - Management of the of operations and maintenance of pump motors
    - OPC Siemens software,
    - SINAUT Siemens software GSM/SMS/GPRS modems,
    - Kepware software Siemens S7-200/S7-300/S7-400/S7-1200 Ethernet OPC
- WiFi
    - **automation**:
        - controllers: **S7 SIMATIC**,
        - controllers: **SZ-21**,
        - devices: **WiFi**,
        - base stations: **SB-21**,
        - controllers: **ST-1**,
        - hubs: **KDP-1**,
        - automation cabinets: **SZA 1.2 SPM**,
        - measuring instrumentation,
    - **organization and management**:
        - warehouse management,
        - operational decisions,
        - operation management,
        - consulting and training.

As can be seen from the above list, presenting the elements functioning within **SPM$_{\textbf{SYSTEM}}$**, the issue of optimization in the management of the operation of wells and submersible pumps is extremely multidisciplinary and relatively complex. Optimization takes into account minimization in electricity consumption and special attention is paid to parametric and field diagnostics in the operation of pump systems. Attention is also paid to the reliability of pump units.

It should be added that **SPM$_{\textbf{SYSTEM}}$** equipment is also adapted to „difficult” conditions (**SPM$_{\textbf{SUPERIOR}}$**, **SPM$_{\textbf{EXCLUSIVE}}$**), i.e. thermal wells, including saline or different pH. Probes and transducers can be made in materials such as hastelloy, duplex and others. The system also has special probes for measuring the internal temperature of the submersible motors, their vibrations and quality control of the liquid that fills the engine.

**SPM$_{\textbf{SYSTEM}}$** is adapted to remote data reading and control via SMS in GSM networks and in satellite communication. This feature practically allows access to the wells anywhere in their location – desert, arctic and other areas.

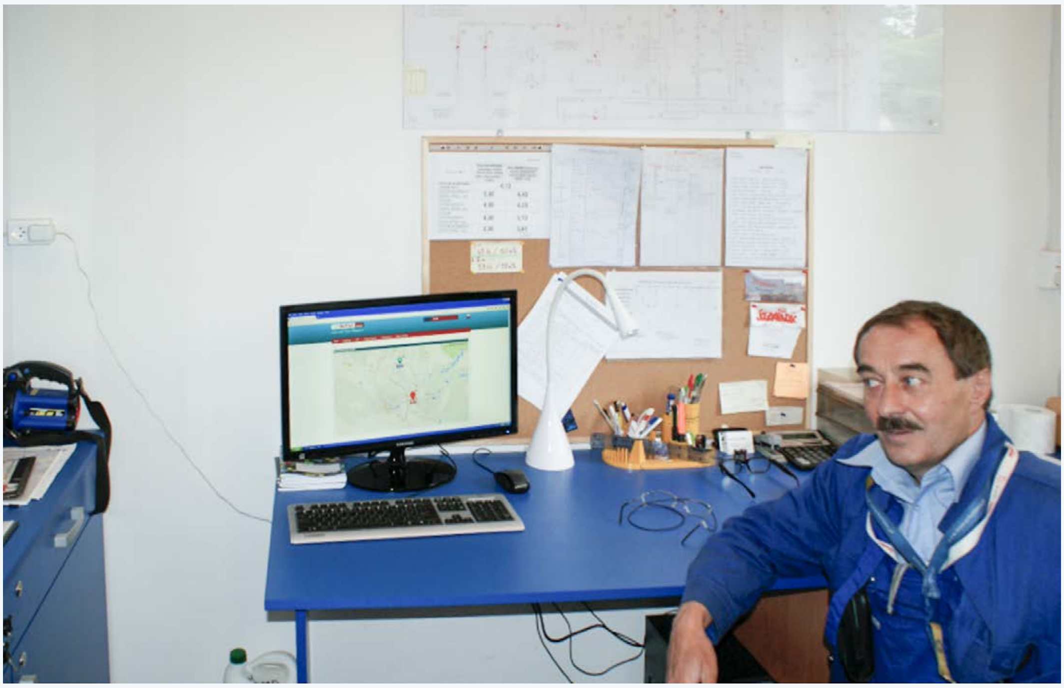


**Figure 25**

**SPM$_{SYSTEM}$** was implemented to the full extent, in ZWiK Myszkow, Poland (Figure 25).


**Figure 26**

**SoftSPM$_{STANDARD}$** software manages the operation of over 800 wells in one of the largest submersible pump systems in Europe – PGE GiEK Branch of KWB Bełchatow – Poland (Figure 26).