Gruppo Enel

Camuzzi

TRAINING FIELD FOR CATHODIC PROTECTION TESTS

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Foreward

As already known by people operating in gas and water distribution, cathodic protection is one of the most important parameters which determine the degree of liability and safety of metallic buried pipes. The relevant advantages, even if difficult to calculate and not having an immediate effect, are nevertheless always economically important and absolutely essential for the good operation of the piping system.

Even if not exhaustively, we can hereunder mention some of the most important advantages:

- reduction of extraordinary maintenance costs of the networks subject to corrosion problems
- increase of the average duration of the pipes and, consequently, economical valorization of the plant
- reduction of gas and/or water leakages with consequent improvement of safety standards.

Which, apart from a better operation, also bring an improvement to the quality of the service to the customers, to the benefit of the image of the distribution company.

But in order to obtain such results we have to face, in a correct and profitable way, the problems concerning design, operation and maintenance of cathodic protection plants.

It is therefore necessary to carry out a specific and detailed training of the personnel in charge with such activity.

In this regard, the italian normalization office (UNI), on April 2000 issued the standard 10875 concerning the certification of technical personnel. By this standard are established the rules concerning the field of application, the levels of certification, the formation procedure and the conditions of the examination.

The Apce (Association for protection against electrolitic corrosion) established the training programs and through its training center, which has at disposal the structures organized by its members recognized by a specific code, develops theoretical/practical training programs in different fields and at different levels of certification.

In order to fully coordinate the standards aspect, APCE stipulated an agreement with CICPND (italian committee for coordination of non destructive tests) qualified by SINCERT, appointing it with the certification of the personnel in charge with cathodic protection and with the aknowledgement of testing centers, according to suitable regulation.

Camuzzi Gazometri S.p.A., now part of Area Gas of ENEL Group, was always interested in cathodic protection and

operated both with a central structure and with peripheric references in order to keep constantly under control the quality and the efficiency of its vast patrimony of gas distributon networks.

In accordance with the ISO 9001 acquired certification, Camuzzi deemed it suitable to have its own training center. The most important unit of this center is the school of cathodic protection, qualified by APCE, suitable for teaching/training activities.

This center is included in the APCE circuit and it is therefore suitable for training and examinations of company and external personnel.

The choice to set the training center within the operation unit of Chieti-Pescara was taken basing on technical and logistic evaluations.

Technical evaluations took into consideration the fact that the gas distribution network of Pescara is strongly interfered by stray currents since on the urban territory the are two electrified railways lines at heavy traffic and an high-power substantion. Thefore the city of Pescara showed to be particularly suitable to this end since it was possible to connect the urban network to the testing pipes of the center. In fact, from a didactical point of view, it is important to have the possibility to transfer also to the testing center those interferences which the network of Pescara is subject to undergo. Also from a logistic point of view, the choice was particularly good since the necessary spaces are available within the UOT (Territorial Operating Unit) real estate and also in consideration of the baricentric location of the distribution company with respect to UOT, the easy road situation and the use of nearby hotels.

DESCRIPTION OF THE TRAINING FIELD

The field is able to simulate and to reproduce the electrical conditions which are to be found in the reality, including the situations due to variable electrical fields generated by direct current traction installations.

On the whole, the field takes up a green ground of about 3,000 sq.mt.

Suitable passages allow the easy access of the personnel to the installations, not preventing the possibility to carry out the measurement of potential by reference electrodes laid undergound above the buried pipes.

The passages extend to housings of transformer-rectifier units, to permanent test points and to simulation devices used by the teachers.

Pic.1 – Panoramic Wiew of the cathodic protection testing field “SX” side

Pic.2 – Panoramic Wiew of the cathodic protection testing field “DX” side

The total extention of the network is of 310 mt. It is formed by:

- mt. 61 of steel pipe Ø 6″ coated with heavy bitumen
- mt. 83 of steel pipe Ø 6″ coated with triple-coat polyethylene
- mt. 62 of steel pipe Ø 4″ coated with heavy bitumen
- mt. 96 of steel pipe Ø 4″ coated with triple-coat polyethylene
- mt. 8 of steel pipe Ø 2″ coated with triple-coat polyethylene

Electrically welded pipes form a double ring, eachone made of homogeneous coated material.

For greater convenience they will be named respectively dx ring and sx ring: dx ring is the one with steel pipe coated with bitumen and sx ring is the one with steel pipe coated with polyethylene.

Five insulating spigot-and-socket joints, installed by the center line of the sections, allow to divide the whole net in 4 electrically independent sections, namely: S1, S2, S3 and S4.

Metallic surfaces are respectively:

- for S1 28.2 sq.mt.
- for S2 32.4 sq.mt.
- for S3 53.8 sq.mt.
- for S4 36.6 sq.mt

The reset of the insulation by the weldings of insulating joints and in general of special items was made by cold worked thermoshrinking sheats and tapes, according to the procedures suggested by the supplier.

One 16 mt. DN125 steel pipe with heavy bituminous coating, indicated on the drawing by a orange continuous line, was buried underground in parallel with the sx ring and at a distance of about 5 cm. Such pipe can be connected to the civic distribution network by a DN65 steel pipe also coated with heavy bitumen and provided with cathodic protection; the electrical separation between the above mentioned pipes has been carried out by an insulating joint on sight.

Short-circuiting this last one, the testing field is interfered by railway stray currents interesting the network of Pescara, besides the location of pipes allows to stimulate contacts among the pipes laid in parallel and with different type of insulating coating.

On two different points of the network and for a lenght of 6 mt, were laid DN200 and DN250 steel sleeves, without coating and provided on both ends with vent pipes complete with aerators.

According to the construction technical procedures of pipes with sleeves, insulating spacers were laid with axle base lower or equal to 1 mt.; closing taps were placed at the ends in order to avoid water and mud infiltrations in the hollow space between pipe and sleeve.

Pic.3 – Railway crossino with cable sleeve

Sheahth pipes allow to reproduce the technical procedures used for road and railway crossings thanks to simulated contacts between pipe and sleeve. Different investigation technologies can be applied for the localization of defects (see detail "A" items "e"-"f").

A piping section of about 14 mt., diameter 4", with triple-coat polyethylene, crosses the ring of the sx net in two points, mentioned on the drawing by "c" and "d". The distance between the pipes, measured vertically, is 20 cm (see detail "B").

A bare copper plait of 50 sq.mm. crosses the dx ring of the net in the points mentioned by "h" and "g"; the distance in depth between pipe and plait is also about 20 cm.

In a DN50 pipe section, 6 mt long, with bituminous coating, laid underground at laying depht of the net of dx ring, was inserted a defect of 280 sq.cm.

Pic.4 – Installation of relay for defect insertion

By such insertion there is the possibility to ascertain, through instrumental verifications, the behavoiur of electrical fields in case of low passive protection. Besides in order to give to the teacher the possibility to point out, according to the type of coating, the different behaviour of electrical fields with or without different defects, were used two steel "pieces of pipe" of about 3 m lenght and diameter 100, one with bituminous coating and the other one with polyethylene coating. They were buried underground in parallel to the rings piping having same coating at a distance of about 20 cm. Insulation defects were made: one of 500 sq.cm. on the section with bituminous coating and two separated defects of 30 sq.cm. each, on the section coated with PE. The position of the sections can be seen in detail "C".

In the demonstration area a metallic housing was installed, which reproduces a final reduction group (GRF) with MP and BP conduits respectively connected to DN125 and DN100 pipes.

Pic.5 – Final reduction group (GRF) with permanent test point

The GRF was installed according to current technical standards and includes all normal devices, such as insulating joints, earthing and equipotential connections.

Two user plugs were prearranged, derived either from dx ring and from sx ring. Both provided with joint, cock and gas meter.

The above was carried out to simulate the reality of distribution which the people operating in the field, must face daily.

TEST POINTS

Along the perimeter of the field, test points were installed, formed by column housings and by boxes mounted on a galvanized steel $1''^{1}/_{2}$ pole. To said boxes arrive the cables for shunts and the normalized connections according to Camuzzi reference standards presently in force.

There are several types of terminal boards, according to the number of cables and to the type of connections.

Pic.6 – Permanent test point with terminal board and ON-OFF switch probe

Test points were constructed with fixed reference electrode of Cu/CuSo4 complete with a strip having a plate having a metallic surface exposed of 30 sq.cm. One push-button mounted on the terminal board allows the opening of the connection conduit/plate for measurments under ON and OFF conditions.

The vaste range of test points, their location, the spaces available for the use of remote electrodes and the possibilty to use permanent and portable reference electrodes, allow the people attending the course to make measurements of current and of potential difference of pipe/ground, with the most updated methods, using suitable meters/recorders.

Characteristics, connections and locations of the 21 test points are pointed out in the following table:

- N° 2 fixed test points on single pipe;
- N° 5 fixed test points on insulating joints;
- N° 2 fixed test points on the crossing of two pipes;
- N° 1 fixed test points on equipotential connections bweteen two parallel conduits;
- N° 2 fixed test points with galvanic anodes;
- N° 1 fixed test points on reduction cabin II° Salto (GRF);
- N° 2 fixed test points on railway crossing of gas conduit;

- N° 2 fixed measurement points on railway crossing of gas conduit predisposed for meters;
- N° 2 fixed measurement points for current by compensation method.

CONTROL BOARDS FOR SIMULATION OF DEFECTS

As previoulsy pointed out, the main aim of the testing field is to simulate and repeat in the most real way the problems that people in charge to cathodic protection meet every day.

It was therefore prevailing in designing and building the field, not only the possibility to enlarge, reduce and divide the piping into electrically independent sections, but mainly the possibity to remote-control the insertion of defects that can be more commonly found. In fact, following problems can be simulated:

- contacts with pipes pertaining to third party
- contacts with earthing installations
- defects of insulation on pipes
- contacts between pipe and sleeve
- interferences produced by installations owned by third party

In order to avoid the interferences attributed to the shunt cables electrically fed, in the testing field were used sequence relays to activate the insertion of defects.

They are impulse-controled and were buried underground in suitable water-proof wells, not on sight, placed near the defect and fed by low voltage. Besides, predisposing the insertion of defects through relays, the metallic continuity between pipe and driving electrical cable was avoided, which could have misled the student in the instrumental search of the pipe (use of pipe and service locators).

In order to facilitate the teaching and the operation of the procedure, controls were gathered in two boards complete with synoptic panel and with warning lights, one for dx ring and the other one for sx ring. The teacher has then the possibility to clearly point out the different behaviour of the phenomena with and without defects, while later he can quickly modify the field characteristics by inserting or disinserting the defects, according to the demand.

Pic.7 – "SX" Defect simulation board

MODIFICATION OF FIELD ELECTRICAL PARAMETERS

The testing field has the possibility to create several investigation opportunities, changing separately or in a uniform way, the electrical parameters on the two rings which form the net.

For instance, acting on "h" or "g" contacts, it is possible to connect dx ring with the earthing plant thus obtaining a remarkable modification to the gradient of the electric field.

By "a" or "b" contacts it is possible to connect the pipes of the testing field to the gas distribution network of Pescara which, as previously mentioned, is interfered by stray currents.

In this way, an electrical field of railway origin can be naturally reproduced, which deviations in intensity and direction cannot be predetermined.

The testing field is provided with 2 independent cathodic protection plants.

One is situated near the dx ring and is connected with a surface dispersor, while the other one is situated near the sx ring with a vertical anodic bed.

Both plants were provided with automatic transformer-rectifier unit, working both on constant ddp and at constant current.

In order to reproduce on the ground an electrical field which gradient deviations, in intensity and direction, can be predetermined and regulated by the teacher, one of the two feeding stations was provided with a suitable electronic installation, working cyclically, which time intervention scale and polarity inversion can be predetermined. Through the transforer-rectifier unit it reproduces a variable electrical field, with behaviour similar to the railway or tramway interfering fields.

Of course when one of the cathodic protection plants is working as disturb, the other one is used to study the operation, the calibration and the set up of the transformer-rectifier unit, in oppositon to the deviations of electrical fields.

CATHODIC PROTECTION STATIONS

Cathodic protection stations at impressed current, installed on the testing field, include the following plants, made on real scale:

- current plants with automatic transformer-rectifier units (A1 and A2 cubicles);
- solar cells plant (A3 cubicle);
- drainage plant (A4 cubicle);

These plants will serve also to instruct the people in charge with installation, erection, maintenance and control of possible defects which appear more frequently.

In the housing, besides the cathodic protection board, there are also: the feeding panel with safety general switch, the limiters of overvoltage and the meter for measurement of electric power and the terminals for anchorage of connecting conductors to ground bed, to the structure to protect and to the reference electrode.

Pic.8 – Typical installation of transformer-rectifier unit with misurament of eletric power meter inside the housing

As previously described, the transformer-rectifier unit placed in A1 housing is connected to an horizontal ground plate formed by 6 Fe Si Cr anodes, weight 13 Kg, made according to UNI italian standards. The transformer-rectifier unit placed in A2 housing is connected to a vertical ground, 50 mt depth, made of 4 steel bars Ø 60, 3 mt long. It too respects the standards previously mentioned. In A3 housing was installed a cathodic protection plant, fed by photovoltaic energy.

The plant is formed by:

- n°1 6 mt. supporting pole;
- n°2 solar panels, 55W peak, each;
- n°1 lighting indicator of the level of battery charger;
- n°1 9Ah battery;
- n°1 12V 3A cc. automatic transformer-rectifier unit for cathodic protection

Pic.9 – Photovoltaic installation for cathodic protection and drainag equipment housing

The photovoltaic system is also connected to the vertical ground plate, previously described.

The drainage plant was carried out placing in the A4 housing one 30A unidirectional unit, made according to UNI italian standards, presently in force.

The equipment is formed by: one unidirectional device, the adjustable resistor, the fuse on the power circuit, the meters of drained current and ddp, and the protections against overvoltage and overcurrent.

In order to simulate the railway line to which the drainage plant is connected, a railway section was installed and on it was simulated a connection scheme, fully in conformity to Italian Railways provisions.

A segregated connection of the railway section to the A2 cathodic protection housing, allows the reproduction of an interfering electrical field and the possibility to insert current between pipe and railway, both in direct and opposite direction.

EQUIPMENT OF THE TRAINING PLANT

The training center is provided with the following instruments and devices necessary for practical training both for passive and active protection.

A) Passive Protection

- N° 2 Coating Analyzers (Holiday Detector) Testing voltage: from 2,5 KV to 30 KV;
- N° 2 Thermometers with measuring contact probe;
- Sections of pipe, not coated, of different diameters;
- Sections of pipe of different diameters, sandblasted;
- Sections of pipe of different diameters coated with bitumen, polyethylene, epoxy resin and cold taped
- Sections of pipe of different diameters coated with bitumen, polyethylene, epoxy resin and cold taped, provided with coating defects;
- Thermoshringking bands and couplings;
- Equipment for application of thermoshringking bands and couplings;
- Equipment and products for repair of leaks in the coatings;
- Materials to be used to insulate the structure from the mechanical protection works.

B) Active Protection

- N° 3 Digital multimeters;
- N° 1 Analogic amperometer;
- Externals Shunts: 100 mV/1A - 100 mV/10 A;
- N° 1 Earhting meter complete with four pickets and electrical connecting cables;
- N° 1 Moving trace recorder for direct current;
- N° 2 Recorders with microprocessor;
- N° 3 Equipment for localization of underground structures;
- N° 1 Equipment for the localization of leaks in the insulating coatings;
- N° 1 Automatic transformer-rectifier unit for cathodic protection, 50 V-10 A direct current;
- N° 1 Automatic transformer-rectifier unit for cathodic protection, 50 V-12 A direct current;
- N° 1 30A Unidirectional drainage;
- N° 6 PortableMovable reference electrodes;
- Sheaths for test points, transformer-rectifier units and devices for cathodic protection;
- Impressed current anodes and types of laying beds;
- Magnesium anodes and type of laying bed
- Cables identification marks;
- Electrical cables of different sections;
- Connectors and accessories for cables;
- Equipment for insulation and connection of cables;

- Equipment for walding of conductors to the structure (brazing Cadwell type, ecc.);
- Materials for insulation of connections to the structure;
- Insulating joints;
- Safety devices against overtension (dischargers, overtension limiters).

LOGISTIC AIDS AND SERVICES

In order to suppport the training center, suitable areas for theoretical lessons were prepared at the unit of Chieti-Pescara.

Inside the same area and near the training field, two classrooms are available, respectively of 77 sq.mt and 30 sq.mt., to be used according to the number of participants. They are suitably provided with fixed and moving didactic aids.

Each classroom disposes of armchairs with writing facilities for the participants, and of suitable desks for the teachers. As for moving didactic aids, they include the following:

- Lighting screen
- Slide projector
- Videorecorder
- Color televison

The above is available for groups up to a max. of 25-30 people.

The proximity of important roads, such as the connection to highways (Roma-Pescara) and A14 (Bologna-Bari), the airport of Pescara and the most important railway connections starting from Chieti and Pescara, make the center easy to reach and easy to locate.

Besides the organization of the center stipulated agreements with local hotels in order to offer suitable accomodation to the people attending the courses.

Last but not least there is the wide parking owned by Camuzzi Gazometri, available for teachers and students. The training field has been designed and built according to the technical procedures of Camuzzi Gazometri S.p.A. which fully comply with safety standards presently in force. There are no preventions, by personnel not pertaining to our company, to the use of the training field, of the rooms assigned to theoretical training and of the instruments and equipment necessary to the above mentioned training.

Therefore such personnel shall have to conform to the general prescriptions issued by Camuzzi for all the people present at the unit of Chieti-Pescara.

TRANING ACTIVITIES

The center was competed in 2000; the activities carried out up to now include two training courses of 32 hours organized by APCE for first level operators and two sessions of tests for the qualification of technicians and operators of 1st and 2nd level.

Besides, each year the center carries out courses of preparation for technicians on management and operation of cathodic protection plants, on use, application and repair of insulating coatings and use of pipe locators.

Courses are mainly dedicated to internal personnel and to personnel of suppliers; always for internal personnel have been carried out courses for technicians and operators in charge with cathodic protection.

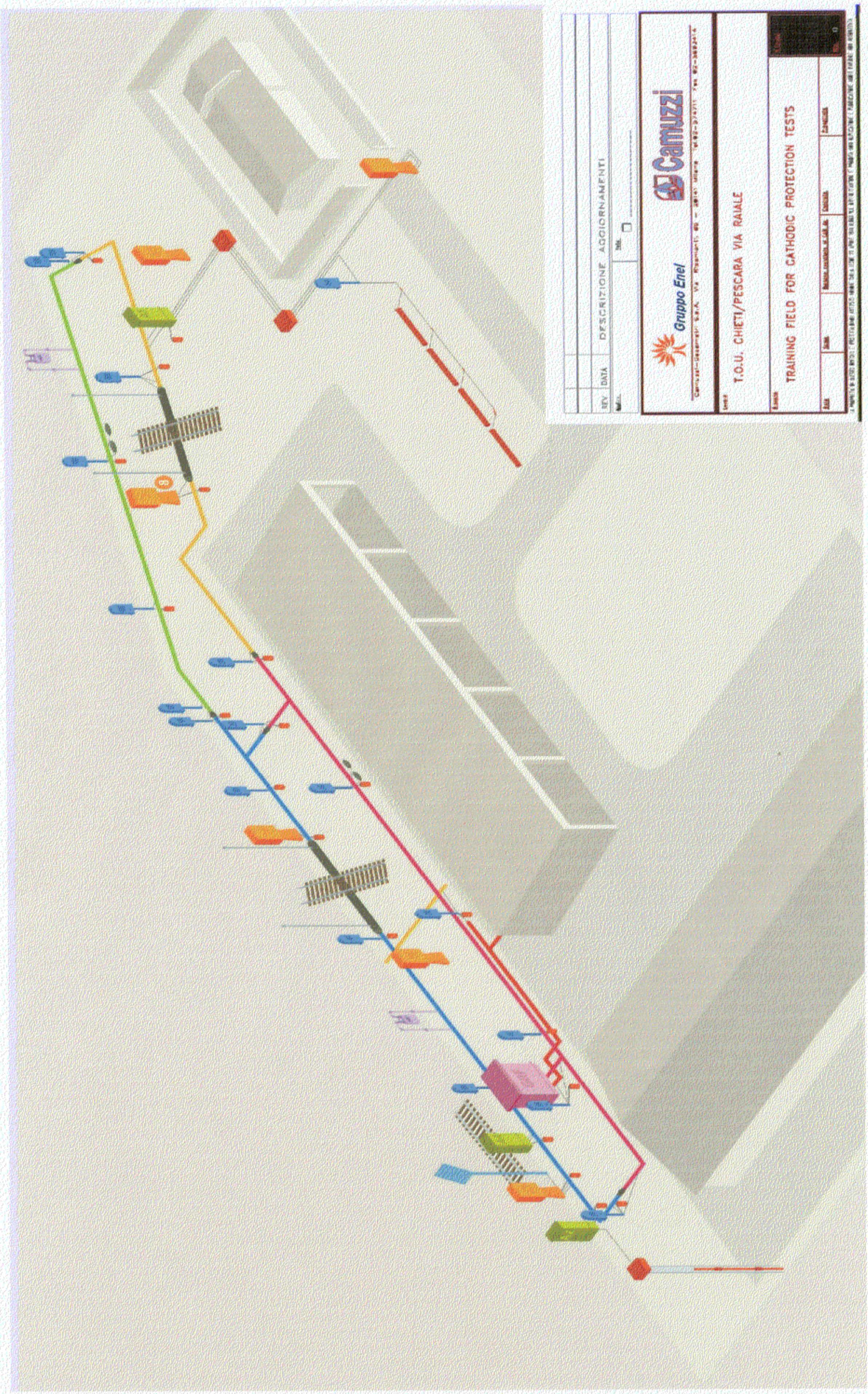
An evaluation of these first two years of activity showed that the training center of Pescara involved each year about hundred poeple; this number is going to increase in consideration of the present size of ENEL Azienda Gas.

In order to give a general information on the ENEL Group Gas Area we remind you some data updated at 31/12/2002 which can give you an idea on the dimensions of the group:

- Contract suply Municipalities : 1,034 Municipalities
- Orwell net length:24,800 Km.
- Total personnel: 1,988 people; 1,279 technician and operators
- customers:1,665,000

In addition to didactical and formation activities the center of Pescara is used to test the new technological innovations proposed by the market in the field of cathodic protection and to try the technical solutions studied and elaborated by the internal technical department. In fact, the possibility to simulate the damages and to base and modify the electrical characteristics of the field, makes such plant a qualified and well equipped control laboratory.

The possibilty to feed with gas the conduits of the plant directly from the civic net, the presence of several peculiarities of the plant and the availability of vaste sheltered spaces allowing the development of works under any atmospheric conditions, make the center suitable also for the teaching and carrying out of training courses in other fields dfferent from cathodic protection, e.g. : maintenance and calibration of reduction groups, search of gas leakages, use and welding of PE pipes etc .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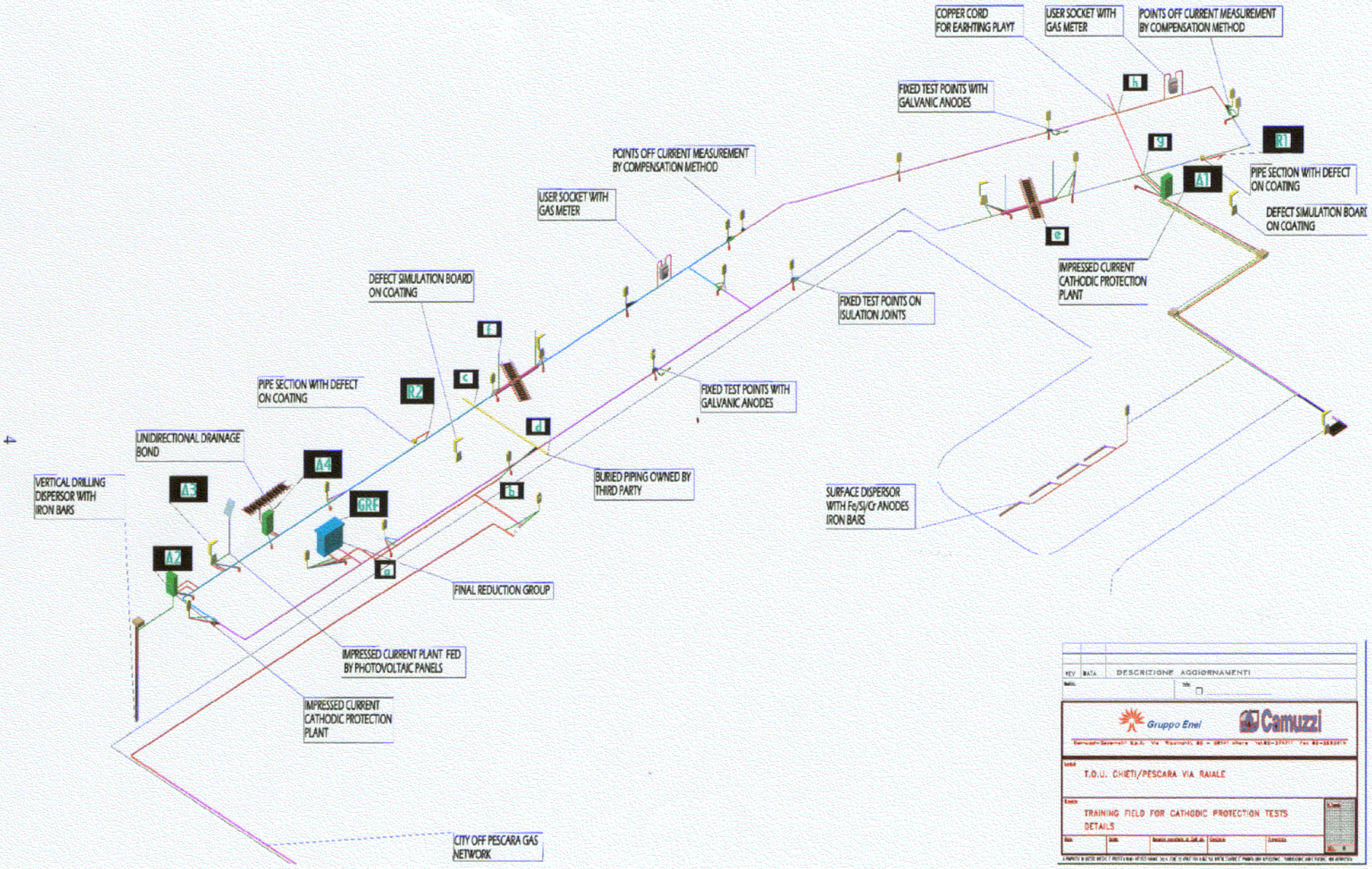
TRAINING FIELD FOR CATHODIC PROTECTION TESTS


COPPER CORD FOR EARHTING PLAYT
USER SOCKET WITH GAS METER
POINTS OFF CURRENT MEASUREMENT BY COMPENSATION METHOD
FIXED TEST POINTS WITH GALVANIC ANODES
h
g
R1
A1
PIPE SECTION WITH DEFECT ON COATING
DEFECT SIMULATION BOARD ON COATING
e
IMPRESSED CURRENT CATHODIC PROTECTION PLANT
POINTS OFF CURRENT MEASUREMENT BY COMPENSATION METHOD
USER SOCKET WITH GAS METER
DEFECT SIMULATION BOARD ON COATING
FIXED TEST POINTS ON ISULATION JOINTS
f
c
R2
PIPE SECTION WITH DEFECT ON COATING
FIXED TEST POINTS WITH GALVANIC ANODES
d
UNIDIRECTIONAL DRAINAGE BOND
A4
A5
GRP
b
BURIED PIPING OWNED BY THIRD PARTY
VERTICAL DRILLING DISPERSOR WITH IRON BARS
SURFACE DISPERSOR WITH Fe/Si/Cr ANODES IRON BARS
A7
a
FINAL REDUCTION GROUP
IMPRESSED CURRENT PLANT FED BY PHOTOVOLTAIC PANELS
IMPRESSED CURRENT CATHODIC PROTECTION PLANT
CITY OFF PESCARA GAS NETWORK
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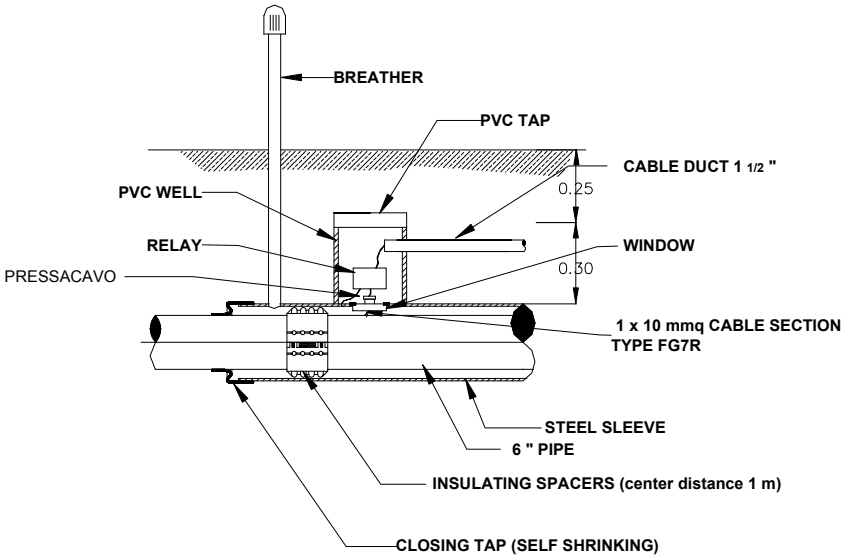
TRAINING FIELD FOR CATHODIC PROTECTION TESTS
DETAILS

TRAINING FIELD FOR CATHODIC PROTECTION TESTS: COSTRUCTION DETAILS

DETAIL "A" (items "e"-"f")



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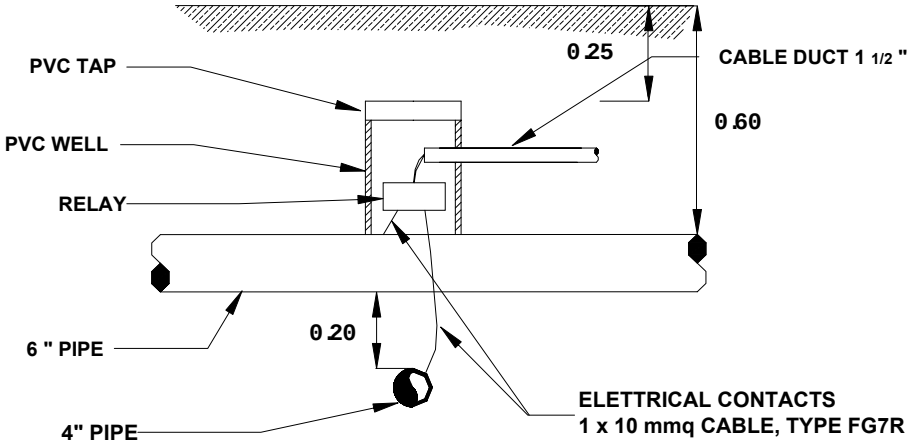

DETAIL C - (items "r^1 - r^2")