

Securing the Chernobyl exclusion zone against illegal movement of radioactive materials

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Abstracts. Within the framework of the IAEA Nuclear Security Program the technical cooperation project “Strengthening Security of Nuclear Materials in Ukraine” (UKR/0/008) is aimed primarily to strengthen protection the entrance/exit checkpoints of the Chornobyl exclusion zone and adjacent State borders of Ukraine against illicit movement of radioactive materials (including nuclear materials). The particular situation of the exclusion zone presents a high risk of uncontrolled movement of radioactive materials from and into the exclusion zone. In view of the future construction of the “Shelter-2” and decommissioning of the three closed reactor blocks it is expected that the traffic through the exclusion zone will considerably increase in the next years and those large amounts of possibly contaminated metal scrap, construction material and equipment will leave the zone. There is also a risk of illegal movement of radioactive waste into the zone, possibly also through the international border, which could make the zone to an illegal dumping ground for radioactive waste. As practice shows theft of nuclear materials cannot be excluded. The general concept of the project is based on modernization of old and deployment of new vehicle (road and railway) and pedestrian monitoring equipment at all checkpoints of the exclusion zone including road checkpoints, train stations and river ports. A central station of data acquisition and management is to be located in Chornobyl. The equipment to be installed has to meet new technical requirements developed by IAEA. This includes, e.g. sensitivity of gamma and neutron detection, identification of innocent alarms caused by NORM materials or medical radioisotopes, accurate indication of the source position in the vehicle, and remote identification of license plate by advanced video systems. The implementation of the project and deployment of the equipment is expected to start in 2003 and should be completed in 2005.

1. INTRODUCTION

The technical project "Strengthening of safety of nuclear materials in Ukraine" (UKR/0/008) is developed within the framework of IAEA Program of international cooperation in nuclear safety. The project puts as its task the strengthening of dosimetric check points (DCP) located at the borders of the Chornobyl exclusion zone and at the state borders of Ukraine with the purpose of preventing the illegal movement of radioactive materials. A situation in the Chornobyl exclusion zone substantially differs from a situation at a typical NPP. First of all it is bound up with the presence of a huge amount of radioactive materials, including contaminated scrap-metal, dispersed over large territory. The latter is characterized by high risk of uncontrolled movement of radioactive materials as from the zone so in the zone. Radioactive materials (including nuclear materials) are placed in the numerous points (of superficial type) of temporal localization of radioactive wastes (PTLRW), which appeared in 1986. The most known and the largest among them is object "Shelter", often named the "Sarcophagus".

In view of future erection of a so called New Safe Confinement "Shelter-2" and decommissioning of the three stopped nuclear reactor blocks it is expected that transport traffic through the exclusion zone will considerably grow during the nearest years, and that a plenty of potentially contaminated metal, building materials and equipment will leave the exclusion zone. Also there is a risk of illegal import of radioactive wastes into the exclusion zone, also possibly through the international border with Belarus. At such a course of events the exclusion zone can become into a territory of illegal dumping of unaccounted

radioactive wastes from outside. In addition, as practice shows, theft of nuclear materials also can not be completely neglected.

A general idea of the project is based on deployment of equipment for monitoring of transport (motor-cars and railway, and river in the future) and the personnel, at all DCPs of the exclusion zone, including points on motorways (Dytiatky, Paryshiv and Dibrova), on the railway (Vilcha, Yaniv and Semikhody) and in river ports (Prypiat river). The central station of data acquisition and management (CSDAM), located in Chernobyl, gathers all information via the integrated information network. The equipment which is needed to set should meet new technical requirements IAEA-Tecdoc-1312 [1]. These requirements include, for example:

- capability of gamma- and neutron to detection,
- capability of identification of false alarm caused by materials containing the sources of natural origin or medical radioisotopes,
- capability of rapid localization of the source in a transport vehicle due to memorization and display of a intensity profile of radiation sensor response along a transport vehicle,
- and also unambiguous remote authentication of a transport vehicle and its license plate by specialized video systems.

The actual launch of the project was planned by the end of 2003 and its accomplishment in 2005.

Within a framework of project maintenance State Specialized Scientific and Industrial Enterprise "Chernobyl Radioecological Centre" (SSSIE "Ecocentre") together with the representatives State department – Administration of the exclusion zone (SD-AEZ) arranged two IAEA expert missions during 2003 (March, 31 – April, 4 and July, 14 – 19). As a result of acquaintance with actual situation during the visits of objects at the exclusion zone (DCPs "Dytiatky", "Paryshiv", "Dibrova", railway stations Vilcha, Yaniv and Semikhody, Prypiat city, PTLRW "Rozsokha") and following discussions the general principles, requirements to and amount of the equipment were produced (table I).

2. BASIC SPECIFIC PRINCIPLES OF CREATION OF THE SYSTEM

Except the general principles of creation of a distributed information measurement system it is necessary to stick to certain specific principles justified by features of the object of supervision and a location of the system. Namely they are as follow:

- Organization of monitoring of nuclear materials with use of neutron detectors, taking into account a vast amount these materials in the exclusion zone, and also physical limitations of other detection methods.
- Organization of monitoring of the inside-zone direction in addition to the outside-zone direction of passenger, transport and freight streams is a preventive measure against illegal dumping of unaccounted radioactive wastes from outside at the territory of the exclusion zone.
- Providing of completeness of monitoring by directions and types of passenger, transport and freight streams for making the channels of illicit traffic of radioactive waste and nuclear materials as narrow as possible.

- Organization of a multilevel automated information measurement system with parallel registration of events (at different levels) independently from an operator will substantially reduce influencing of the human factor (e.g., absence of operator response under extraneous influence or due to negligence).

Table I. Composition and amount of equipment to be supplied within framework of the project UKR/0/008 united in result of the two expert missions.

DCP (covered geographical direction)	Stationary installation (γ , n)	Installation for monitoring of superficial contamination (β , γ)	Portable radiometer (γ , n, α , β , spectral analysis)	Pocket radiometer (γ , n)
Dytiatky (South, Kiev)	2 track systems (with 2 pylons and 1 videos), 1 AWP (*)	5	3	10
Paryshiv (North, Belarus border, Slavutich)	1 (reversible) track system with 2 pylons and 2 videos, 1 AWP	3	2	5
Dibrova (West, Polissia)	1 (reversible) track system with 2 pylons and 2 videos, 1 AWP	2	3 (2+1) (**)	5
Vilcha (West, railway towards Ovruch, Polissia)	1 (reversible) railway system with 2 pylons and 1 videos, 1 AWP	--	--	
Yaniv (North and West, transit near Chernobyl NPP)	1 (reversible) railway system with 2 pylons and 1 videos, 1 AWP	--	--	
Semikhody (North, Belarus border, Slavutich)	2 pedestrian systems (with 1 pylon and 1 videos), 1 AWP	--	2	
IN TOTAL:	7 systems, 14 pylons, 10 videos, 6 AWP	10	10	20

Remarks:

(*) AWP - automated workplace.

(**) 2 devices for use at DCP "Dibrova" and 1 – for response at Vilcha.

3. SPECIFIC TECHNICAL REQUIREMENTS TO THE SYSTEM

In result of discussions and basing on international experience as well as concrete specific situation in the exclusion zone, the following specific technical requirements (which should be taken into account for creation of the system) were agreed:

- Every new stationary system is equipped with video survey and lighting for the night-time. Video survey is extended by means for optical character reading of car license plates into a computer database. Video survey is synchronized with detection response (using software) for rapid localization of radioactive material hidden in the car.
- The first priority of work in 2003 was assigned for DCP "Dytiatky". However, after the accident at DCP "Paryshiv", when the lightning in May, 2003 fully destroyed a working set of equipment "Kordon", the priority was operatively switched to this DCP.

- Every DCP should be equipped with a single monitoring room, with video monitors, indoor and outdoor alarms (both audio and light), computer data collection system (including corresponding software in Ukrainian), data transfer and telephone communication with the CSDAM. The monitoring room is physically secured.
- Additional requirements to software both at DCP and CSDAM levels: operational system is of MS Windows 2000 type, verification of physical and logical integrity of databases, means for different events indication as well as regular data analysis and report issuing, computer virus protection, backup (software and hardware).
- The CSDAM is located in Chornobyl.
- Data transfer from the DCPs to the CSDAM should be maintained in the real-time mode (including image data for alarm moments) preferably by wireless communications. As an example of such a communication network the SkyLink™ system can be considered.
- Each computer data collection system at all the DCPs should have sufficient data storage in case of temporary loss of connection with the CSDAM. Further, each consol of all the stationary systems should have sufficient data storage in case of temporary loss of connection with a local computer data collection system. Every cessation of work or disconnection should be registered and reported automatically.
- Complete automated diagnostics of any component of the system should be provided at three levels, i.e. (1) at consol level, (2) at level of a local computer data collection system (DCP) and (3) at level of the CSDAM.
- All the stationary systems should be equipped with UPS (uninterruptible power supply).
- Requirements to stationary contamination monitor: minimal detectable level is less than 20 beta-particles·min⁻¹·cm⁻² (for each detector) in 5 sec using 10-12 independent channels (detectors).
- Preference should be given to suppliers of the equipment who are able to provide and maintain metrological certification, guarantee and post-guarantee-service in Ukraine.
- Installation, acceptance testing and calibration of the equipment as well as design, construction and building works, and also license measures and additionally fellowships and training of the personnel should be included as a part of the project.
- Spare parts of equipment as well maintenance kits should be included as a part of the equipment delivery.
- Other requirements should correspond to IAEA-Tecdoc-1312 [1].

4. FUTURE DEVELOPMENT OF PROJECT

Envisaging further development of the system it was admitted as the most perspective the following directions:

- modernization or organization of new DCPs around the Chornobyl NPP, namely: on the railway station Semikhody, and also several DCP along the perimeter of the Chornobyl NPP site;
- modernization or organization of new internal DCPs at the territory of the exclusion zone at "Leliov", "Buriakivka" and "Vector" for monitoring of radioactive waste transportations;

- organization of mobile facilities of radiation monitoring and inspection equipped with the portable radiometric devices coupled with GPS and wireless on-line communication with CSDAM.

5. INFORMATION ON PRESENT AND PLANNED DCP

Dytiatky. This DCP is a Southern entry/exit point of the exclusion zone and has the highest passenger and transport traffic. Motor transportation takes place in both directions in average of 1500 cars a week with a peak occurring on Monday and Thursday, up to 500 cars a day. Presently radiation monitoring of transport is carried out at exit from the zone by means of single two-pylon installation "Positron Kordon plus" (manufactured by company Positron, Zhovti Vody city, Ukraine). Scintillation detectors NaI are used in this system. For the time being the system "Positron Kordon plus" have not been certified in accordance with the international requirements (ITRAP (Illicit Trafficking Radiation Detection Assessment Program) and IAEA TECDOC-1312 [1]). The personnel is passed radiation monitoring separately. For that the passengers leave cars and pass through superficial contamination monitors. For this type of monitoring 4 stationary devices RZB-04-04 (of Russian production, about 20 years old) are used in parallel. For additional radiation contamination monitoring portable γ - β -radiometer MKS-1 (of Russian production) are used. Plan of the suggested modernization of DCP "Dytiatky" is presented on figure 1.

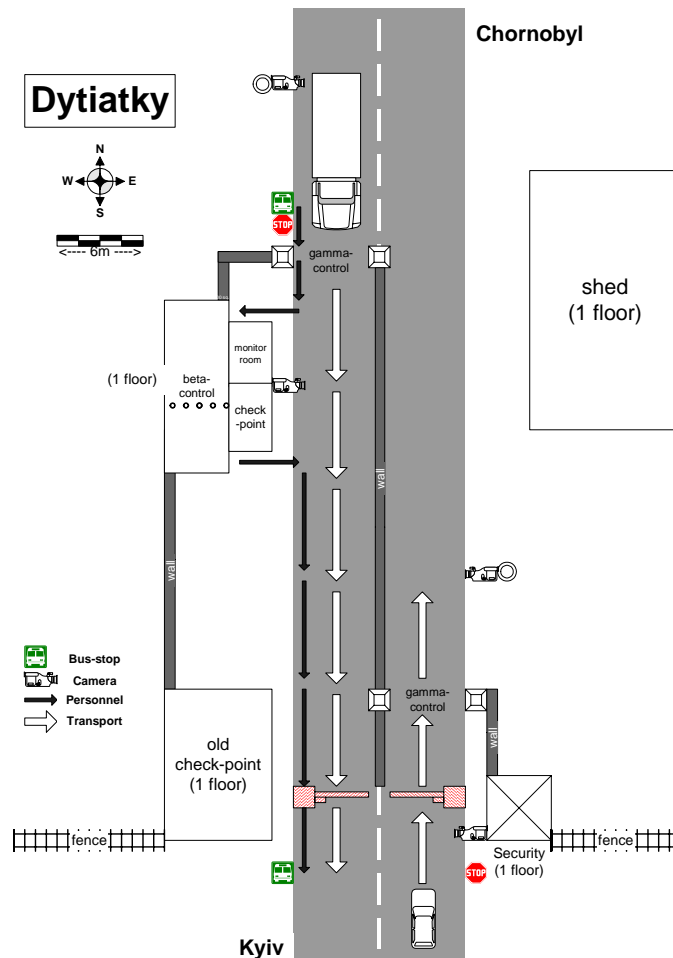


FIG. 1. Plan of the suggested modernisation of DCP "Dytiatky"

Paryshiv. This DCP is located at North-Eastern entry/exit point of the exclusion zone and is adjacent to the corridor, that belongs to Belarus, and which connects the exclusion zone with Slavutich. This city was specially created after the Chornobyl accident. About 20 thousand people (part of which work in the exclusion zone) now live there. An access motorway to the exclusion zone passes through Paryshiv, although there is also railway communication between Slavutich and the zone. This railway is used by majority of the personnel of the Chornobyl NPP for daily round trip in the zone. Paryshiv is characteriied by relatively low intensity of traffic of less than 100 cars a day, and, consequently, it is sufficient single two-pylon installation that will provide both directions of movement. Presently transport is controlled only at exit from the exclusion zone by two-pylon installation "Positron Kordon plus". For the monitoring of the personnel 3 stationary devices for superficial radiation contamination monitoring (RZB-04-04) are used in parallel. For additional radiation contamination monitoring portable γ - β -radiometer MKS-1 Plan of the suggested modernization of DCP "Paryshiv" is presented on figure 2.

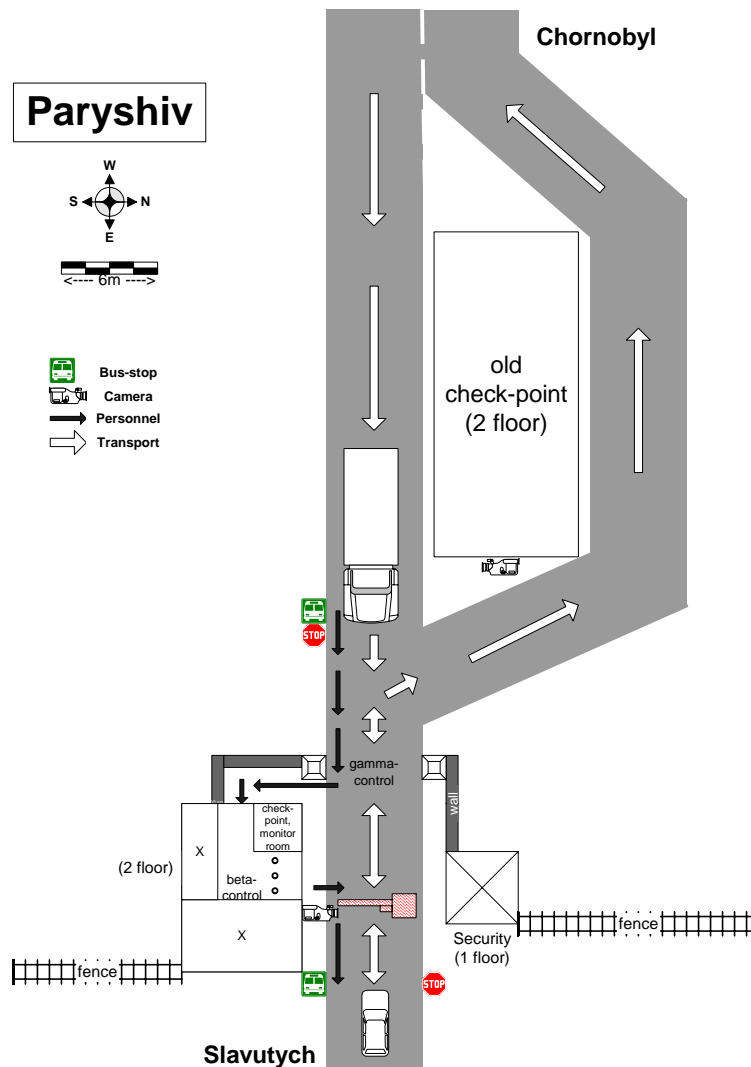


FIG. 2. Plan of the suggested modernisation of DCP "Paryshiv"

Dibrova. Importance of DCP "Dibrova" is determined by fact that it effectively blocks the westward direction of traffic and also is located on the border between the exclusion zone and the zone of absolute (obligatory) resettlement (figure 4). All detour roads round DCP "Dibrova" are physically blocked. DCP "Dibrova" is located in the distance a 40 km straight to West from Chernobyl. There is a separate house for suitable and ready for arrangement of monitoring room and placing there installations for superficial radiation contamination monitoring of the personnel. Plan of the suggested modernization of DCP "Dibrova" is presented on figure 3.

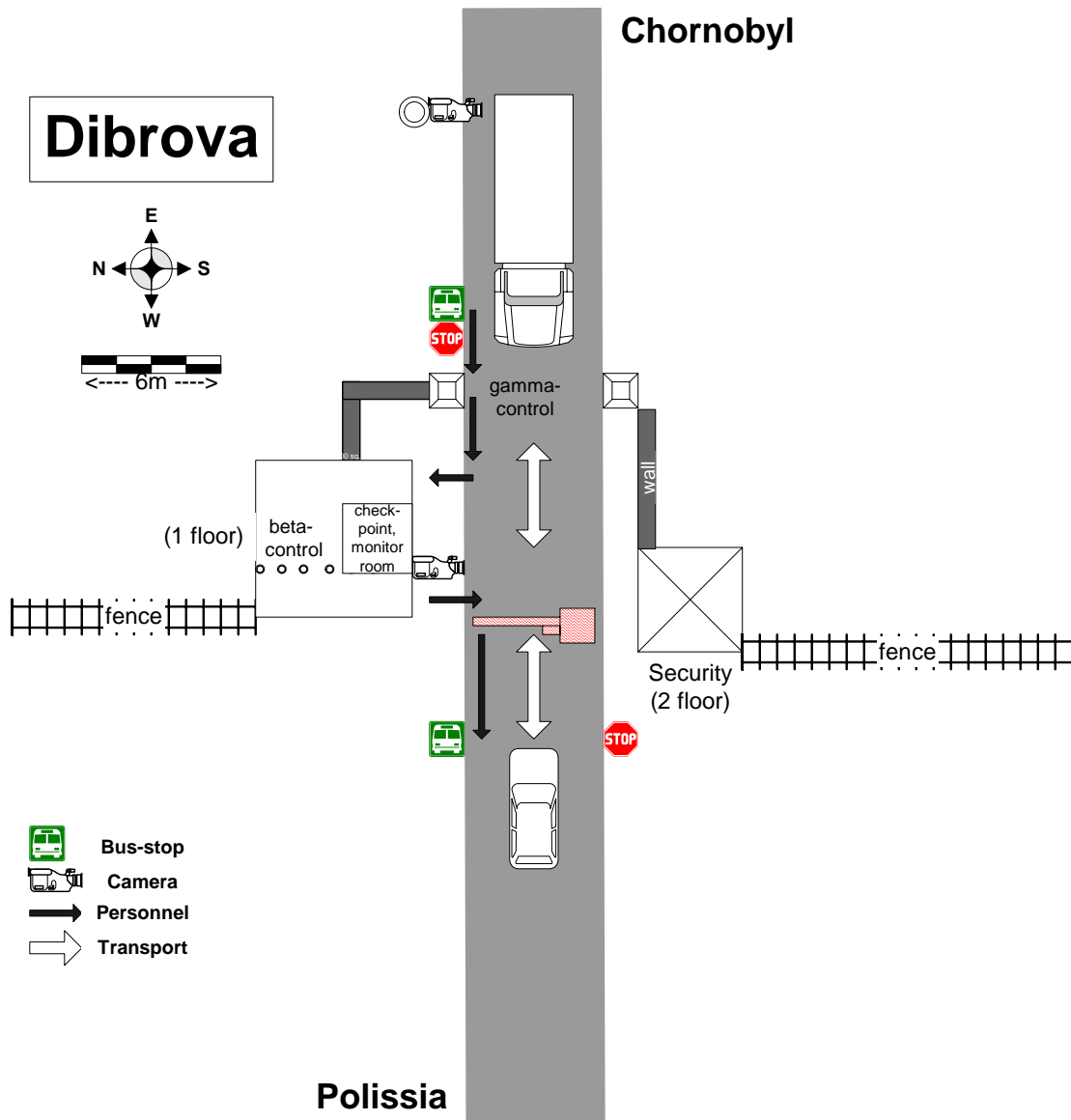


FIG. 3. Plan of the suggested modernisation of DCP "Dibrova"

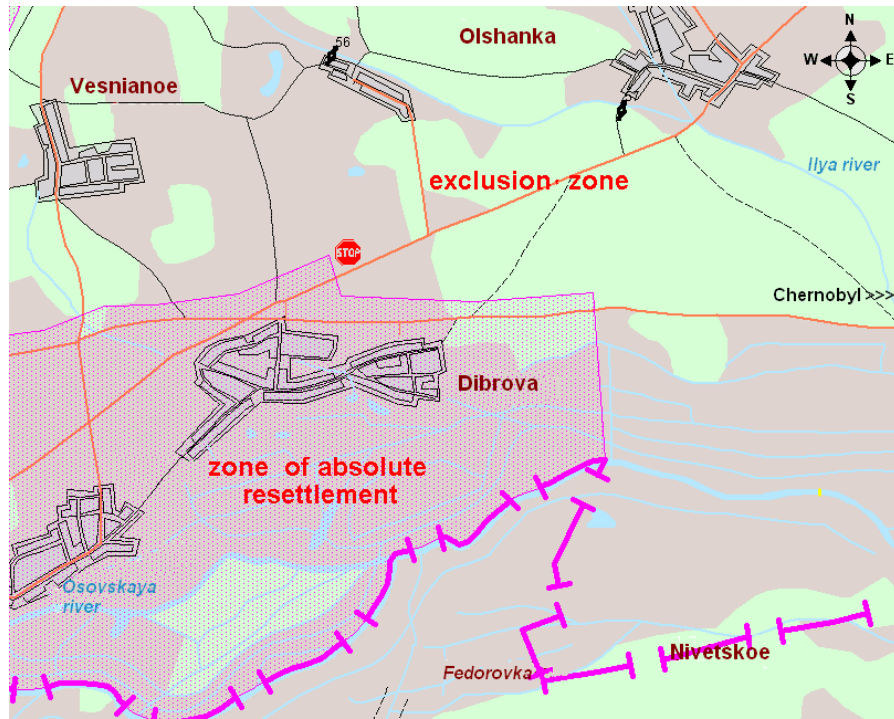


FIG. 4. Map of a district around location of DCP "Dibrova"

Vilcha. The railway station Vilcha is located immediately after exit from the exclusion zone and at the territory of the zone of absolute (obligatory) resettlement near the border between Kiev and Zhytomir regions (figure 5). Vilcha is in 18 km to North-West from DCP "Dibrova" or 30 km on the motorway. The railway station Vilcha is under operation of the Ministry of transport. It is the only operating railway station at the West of the exclusion zone and the zone of absolute (obligatory) resettlement. Only freights pass through the station and no passenger transportation is allowed. Today on average 70 freight carriages pass through the station monthly towards the Chornobyl NPP.

The railway station Vilcha has 4 parallel lanes and internal branch to the ware-house of State specialized enterprise "Chornobyl Forest", where carriages are loaded with timber. In connection with the relatively complex structure of internal ways and necessity of providing the effective response three possible locations of the detection system were considered (figure 6). Although it was agreed the setting of a single system at railway station Vilcha, however, it was admitted that only two systems set at Western and Eastern ends of the station will provide maximal security of monitoring results and independence from the human factor.

Semikhody. The passenger railway station Semikhody is adjacent to the changing facility of the Chornobyl NPP. The station was built after the Chornobyl accident for providing of transportation of the personnel living in Slavutich. The railway station belongs to the Chornobyl NPP. Usually 4 electric railways daily arrive to and depart the station, carrying about 3200 of the personnel of the Chornobyl NPP (without taking into account the contracted personnel). A passageway between the train station platform and the changing facility is strictly controlled by the security and the radiation safety service of the Chornobyl NPP. Semikhody are at the distance of 16 km by straight line to North-North-West from Chornobyl and of 19 km by motorway. Plant of the Semikhody station and location of a new installation for nuclear material monitoring for the personnel is presented on figure 7.

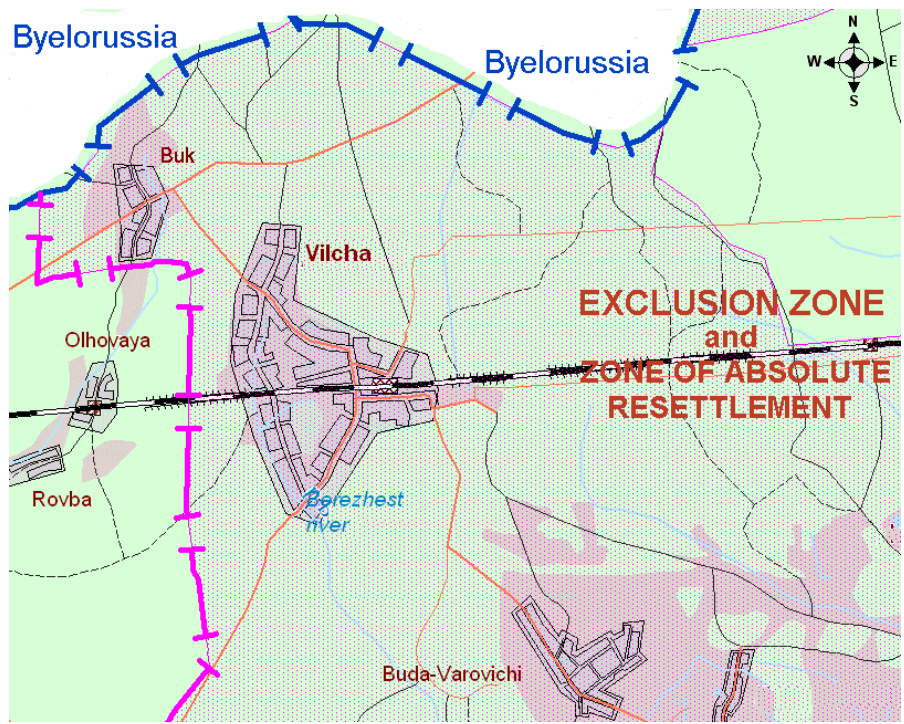


FIG. 5. Map of a district around location of the railway station "Vilcha"

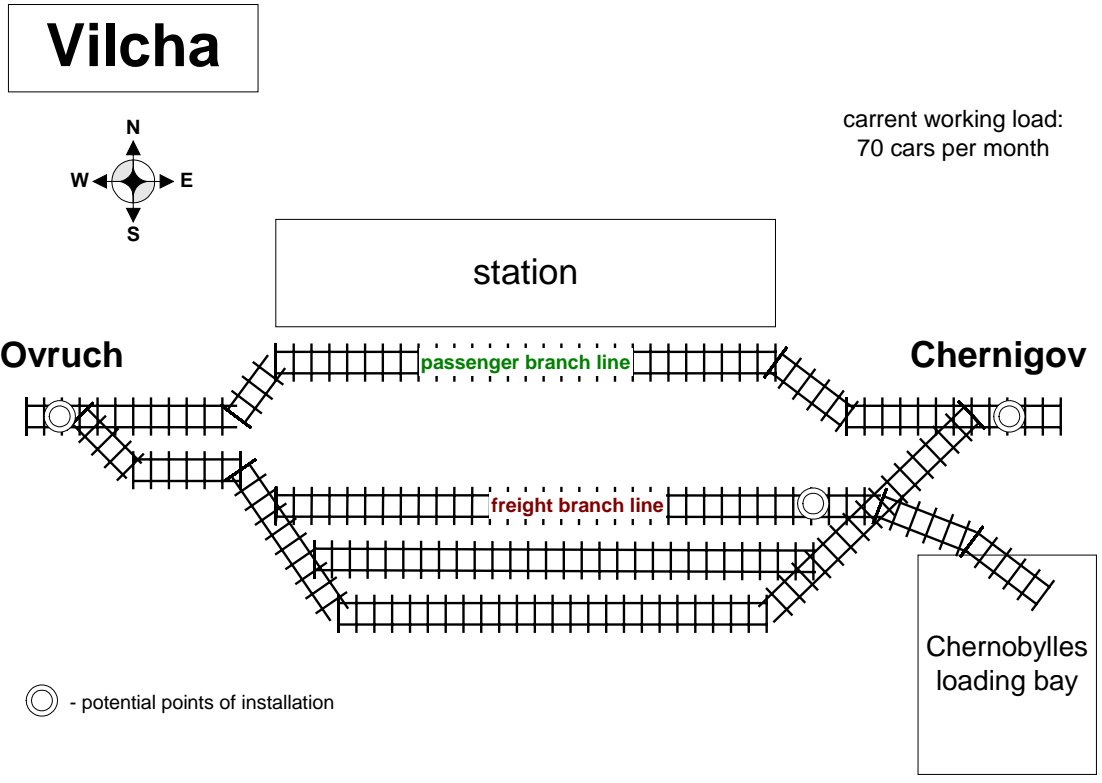


FIG. 6. Plan of new railway DCP "Vilcha"

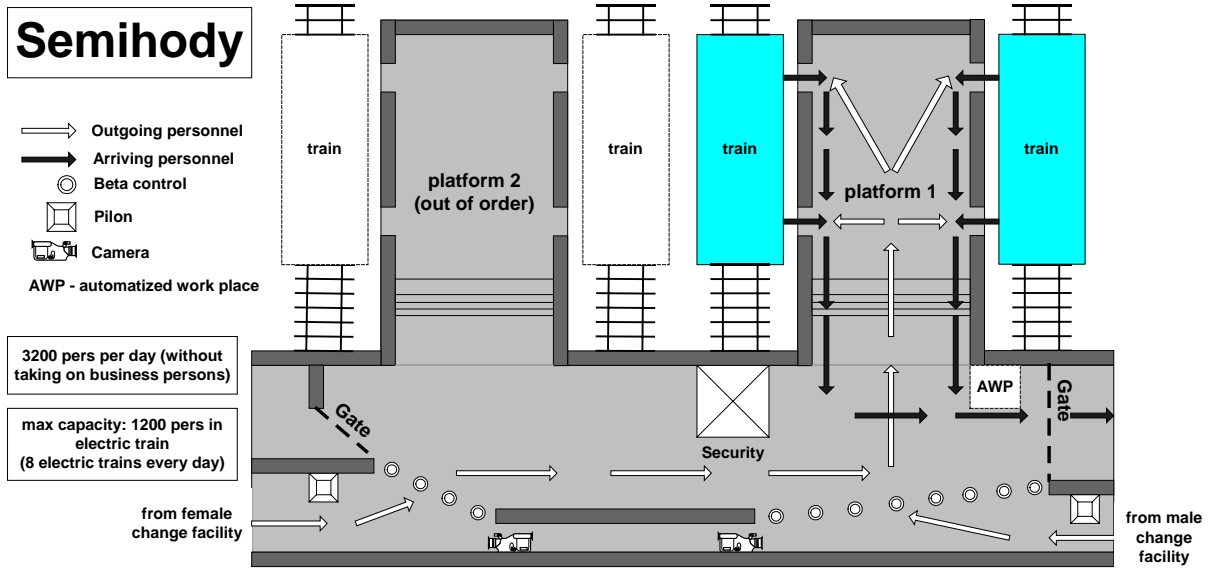


FIG. 7. Plan of new passenger DCP "Semikhody"

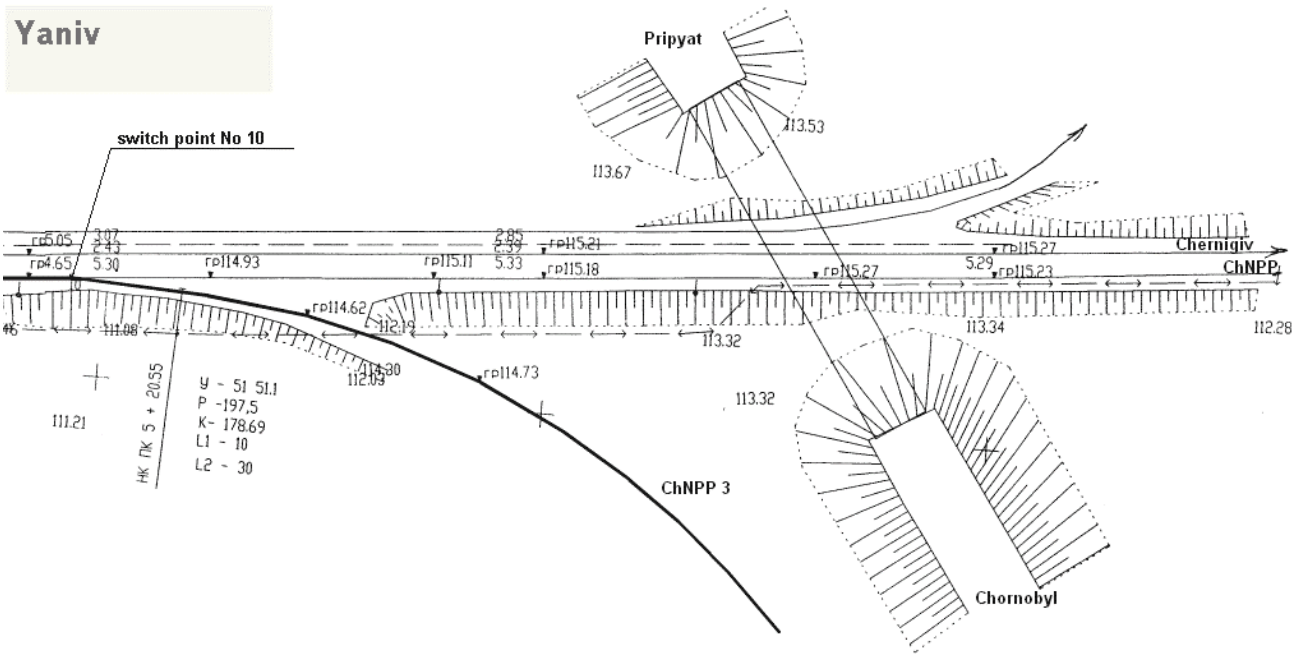


FIG. 8. Map of a district around location of the railway station "Yaniv"

Yaniv. Actually the railway station Yaniv is not used by the Chornobyl NPP. All freight flow of the Chornobyl NPP, that goes out to Slavutich and Chernigiv by railway does not achieve the Yaniv station, returning at switch point No. 10. Thus, the railway section between switch point No. 10 and Semikhody looks the most suitable for setting of detection part of the system. AWP for this system can be located in the nearest houses, that belongs to the Chornobyl NPP, namely: administration of object of "Shelter" (300 - 400 m) or PMU (400 - 600 m). Deployment of equipment at Yaniv requires the preliminary search of place with minimal level of dose rate. Also additional passive protection for detectors may be possibly needed. The AWP is remote as far as 1 – 1.5 km from Semikhody and 16 km by straight line to North-North-West from Chornobyl (19 km by motorway).

6. REFERENCES

1. Detection radioactive materials at borders (IAEA-TECDOC-1312). IAEA, Vienna, 2002, 44 p.