INDUSTRIAL RADIOGRAPHY IN CROATIA – NEW APROACH

Mladen Novakovic,
EKOTEH dosimetry Co. Radiation Protection,
Zagreb, Croatia

1. Summary

In Croatia there are 20 users of industrial radiography equipment. More than 100 persons are engaged in operating this equipment. According to the new legislation individual radiographers shall be adequately trained and authorised prior beginning of work. This basic training is organised jointly by Croatian Radiation Protection Institute (CRPI) and Croatian Society of Non - Destructive Testing and technically it is supported by Faculty for Mechanical Engineering and Naval Architecture of University of Zagreb. Basic training is carried out in a systematic manner to enable trainee to adopt the techniques required to obtain a radiograph, as appropriate to the duties, and specialised training in radiation protection and safety. During the course all trainees are familiarised with understanding of the emergency measures and procedures, together with training in the use of the protective and emergency equipment. Special care is devoted to field industrial radiography because in Croatia almost two third of all radiographs are done in open space: shipyards, bridge constructions, pipelines etc.

Periodical re-training is mandatory at intervals of 5 years to maintain the required level of competence of radiographers. Individual radiographers are required to have personal authorisation (certificate) based on the training.

In spite of these recent efforts the situation is far from satisfactory because these workers are still among those receiving the highest personal doses. This is partly because old and obsolete radiography equipment and partly due to poor safety culture leading to negligence of safety precaution measures. So further improvements: technical, operational, organisational and educational are necessary to reduce exposure of radiographers.

2. Introduction

The value of industrial radiography in non-destructive testing has been established over the last 100 years and earned a strong status both in the production and in maintenance. Regulations and standards have been legally promulgated, their implementation established, the criteria of acceptability introduced, training of personnel benefited with a high level of their competence and testing equipment is of increasing reliability and efficiency. Procedures and testing using industrial radiography have become part of the contracts on the construction and maintenance of various facilities. Regarding the ever increasing demands for determination of the conditions of materials, their properties and behaviour during exploitation, high quality criteria of acceptability are created, testing is rationalised and costs reduced. Owing to industrial radiography welding has reached the high level of development and application of new techniques.

The same requirements that have to be met by the products and services in EU should also be met by the Croatian products and services. The State Bureau for Standardisation and Metrology has brought an Act on Standardisation and has adopted a system which operates within EU. Compliance to standards can be agreed upon within a wider circle of participants, thus trying to reach quality level within a certain activity. By developing a system of trust based on the harmonised testing, the members of the system issue regulations of general validity and they come into force throughout the Europe without any special documents of acceptance. This is precisely the case with non-destructive testing. The European standards 473 and EN 45013 assure harmonised certification of personnel engaged in non-destructive testing and accreditation of training centres for non-destructive testing within EFNDT (European Federation for NDT).

It is recognised that the quality of non-destructive testing depends mostly on the skills of the examiners to carry out certain testing, i.e. on their knowledge and experience that usually comprise the knowledge about the object of testing, testing methods, handling of equipment, assessment and interpretation of the achieved results.

Training of employees for non-destructive testing and non-compliance with the precisely defined standards and existing system of training is most often the problem of the management. The management has to ensure adequate training for those employees who have influence on the quality of the product to be delivered or services to be provided, regardless of the method, place and time of testing.

During its forty years of operation, the Croatian Society for Non-Destructive Testing (CrSNDT) has been continuously training and certifying professionals for the work in the field of non-destructive testing in accordance with EN and the relevant international standards. CrSNDT is a non-profitable society of professionals founded in 1964 for the needs of training personnel in the field of non-destructive testing. During these years the CrSNDT has contributed immensely to the Croatian industry since this specific type of training has not been provided by any of the education institutions, and even today it can be found only in segments at the by Faculty for Mechanical Engineering and Naval Architecture of University of Zagreb. CrSNDT experts have developed and improved training and certification to a high level. Skilfulness and quality of knowledge of trainees have proved validity of their certificates wherever the Croatian industry and personnel are involved providing their quality assurance services

But what was or still is the price for these achievements? Until today, to many workers engaged in industrial radiography testing had received high doses, even above 10 mSv in a year, and what is worse even regularly.
Industrial radiography in Croatia accounts for a significant number of radiological accidents. Some of them have been reported but some times they have been covered up.

Despite advances in equipment design and improved safety systems, overexposures and accidents continue to occur: primarily, because of failure to follow operational procedures, inadequate training, human error, inadequate maintenance of equipment and sometimes even wilful violation and, occasionally, because of inadequate regulatory control. This problem arises across the entire cross-section of workers, from the most senior and well trained, who may become complacent, to the less experienced and poorly trained.

Problem occurs when new initiatives to improve situation affect usual philosophy and tradition. Subsidiarity is often used as an excuse not to take any action at all. Then you need some pressure, usually through legislation to effect change. There was perception from authorities and experts in Croatia that there is a need and possibility for improvement of the radiation protection measures in this field. The main objective of the new regulations was to achieve an acceptable low level radiation risk for the radiographer and his assistants as well as for other personnel and the general public.

Since industrial radiography involves use of relatively strong radiation sources it is also an important aim of these regulations to reduce the risk for radiation accidents.

3. Regulatory background for improvement of radiation protection and safety of radiographers

Croatian legislation on radiation protection is governed by the new Law on the Protection against Ionising Radiation [1] and the regulations developed for its implementation. They cover practices, interventions and work activities taking into account recommendations of the ICRP Publication 60[2] and IAEA BSS[3]. The scope of the Law covers all practices, including industrial radiography. In addition, articles 6 and 7 of the Law confirms that all exposures are subject to the principles of justification, optimisation and are subject to dose limitation principle as well. On 30 August 2000 Minister of Health (National Regulatory Body) issued a regulations laying down basic requirements for using radioactive sources or X-ray apparatus within practices involving exposure to ionising radiations [4] [5]. This regulation complemented the Law as regards the protection of individuals handling sources of ionising radiation within a range of practices including industrial radiography. The merit of the Regulations is not only that they entail legal initiatives to regulate radiation protection in Croatia but they also create the necessary platform for the further development of a “radiation protection culture” in this field. Many of the stipulations in the regulations are results of application of the optimisation principle laid down by ICRP and others.

Several strategies have been laid down into Croatian legislation to reduce the number of inadequate exposures and to avoid accidents. There are requirements related to the duties of the holder of the installation and to the supplier and manufacturer regarding equipment. Many of these requirements have been and still are standardised features in industrial radiography facilities: strict surveillance, the criteria of acceptability (minimum criteria) for equipment, steps to be taken in case of inadequate or defective equipment and the availability of an

inventory. Some of these requirements have been strengthened by the new regulations and some new features are introduced:

1. Centralisation of all relevant data within Croatian Radiation Protection Institute (CRPI) about practices, sources and workers involved in practices,
2. Concept of quality assurance programmes and quality control measures, including acceptance testing and performance testing of the equipment:
3. Training, and continuous training of the professionals in the field of radiation protection is strongly emphasised,
4. Licence for the practice (i.e. industrial radiography) as the precondition for obtaining the separate licence for the source within practice have been introduced. Only licence for the source was needed according to old regulations.

Figure 1. is depicting how a regulatory infrastructure is established in Croatia. It depicts also a communication network of relevant documents among involved parties.

Figure 2 depicts organisation of personnel monitoring in Croatia as well as the record keeping and communication network of information on the subject.

Figure 3 is an example of submitting relevant data on the source used within practice to the central database of CRPI. Registration of the source at CRPI database is one of the preconditions for obtaining the licence for the source.

Any person or company wanting to perform industrial radiography shall prior to purchasing radiography equipment obtain a licence from the national radiation protection authority. The term purchase includes buy, rent and borrow.

The licensee has the responsibility for the fulfilment of the national radiation protection regulations. To obtain this licence for practice it is necessary for the licensee to verify competence and organisation as described below:

1. In all companies and establishments performing industrial radiography a radiation protection officer shall be appointed to take care of all relevant aspects of radiation protection. He must be given the authority necessary to perform his duties. The radiation protection officer shall be approved by the national radiation authority, theoretical skill and practical experience taken itnto consideration as well as participation in the radiation protection course organised by CRPI.
2. Radiographers and their assistants shall have satisfactory knowledge of the fundamentals of radiation protection and proper use of all radiographic equipment which is encountered during the work. They must fulfill prescribed health conditions as well. They should pass health examination prior starting their work with sources of ionising radiation.
3. The licencee shall provide a system for control of radiation protection at his establishment. In particular routines for regular checking and maintenance of the equipment shall be set up. This should be done by engagement one of the approved legal persons for radiation protection. These legal persons are approved by Minister of Health as a technical support assisting the authorities and inspectors in the process of ensuring that licence holders comply with regulations.
4. The licensee shall provide a monitoring system with personal dosimeters provided by the service approved by the Minister of Health as the national radiation protection authority.
5. Contigency plans for action to be taken in the case of radiation incidents shall be prepared. In case of incidents detailed reports shall without undue delay be presented to the national competent authority.

Regulations include a number of issues, which have potential to improve the safety and quality of radiation protection for industrial radiography workers. Four types of requirement pursue these objectives:

a) Provisions related to duties, responsibilities and qualifications of the staff;
b) Provisions related to equipment;
c) Provisions related to procedural requirements;
d) Provisions related to emergency situations.

Before radiography is started the licensee shall make sure that the following requirements are fulfilled:

1. The purchasing of each set of X-ray or gammaray equipment shall be approved by the national radiation protection authority.

2. All radiographic equipment including the equipment needed for safe operation such as radiation monitors, collimators, diaphrgms, warning signs, roping etc., shall be available in proper condition whenever a radiography task is presented to a radiographer.

Articles of the regulations focused on radiography apparatus and instruments for measurement of radiation have to a certain extent been based on existing national and international recommendations issued by the International Standards Organisation (ISO) and the International Electrotechnical Commission (IEC).

There are no manufacturers of equipment for industrial radiography nor manufacturers of gamma sources for gamma cameras in Croatia. Industrial radiography equipment and sources should be imported from suppliers abroad. By exclusively licensing the importer and strict administrative and operational control at the borders we expect that illicit purchasing of strong sources would be reduced to minimum.

Training and high qualifications criteria are unfortunately no guarantee against decisions to bypass safety systems. Voluntary compliance with safety standards is normally quite high but pressure of time, economic competition, or worker dissatisfaction, can result in a serious violation of regulatory standards.

By the law and regulations the regulatory authority has sufficient authority to impose sanctions that will deter deliberate or careless deviations from regulatory standards. A strong and effective enforcement programme is strongly supported by frequent inspections of these facilities and revalidation of licenses after one year time interval. These enable the competent authority to review licensing conditions and that registration details could be kept more up-to-date.

Safety may be compromised if the regulatory controls that encompass licensing, inspection and enforcement are not in place. However, the importance of a well established regulatory authority should not be overestimated. The operating organization bears the prime responsibility for the possession and use of the industrial radiographic sources and devices, but the primary responsibility for personal safety lies with the radiographer. Clearly adequate training and re-training of industrial radiographers is a most important factor in establishing end maintaining a safety culture throughout the entire organization.

No industrial radiography should be undertaken by personnel who do not have sufficient knowledge and skills in the field of radiation protection. Licensees shall ensure that all person involved in industrial radiography are adequately trained.

CrSNDT in association with Faculty for Mechanical Engineering and Naval Architecture of University of Zagreb, developed an organised system of specialized formal training in the techniques required to obtain a radiograph. This formal training of industrial radiographers including certification according to the current standards (EN 473 and 45013) is carried out in a systematic manner in accordance with the requirements of the European Federation for Non-Destructive Testing (EFNDT).

According to the Law and regulations[6] in Croatia CRPI is nominated to organise specialised training courses in radiation protection and safety for all workers involved in industrial radiography. Only radiation courses organised by CRPI are recognised by the competent national authority as fully qualifying.

Radiographer independently performing industrial radiography work must have attended a radiation protection course giving the necessary competence in this field. Training for radiographers consists of both practical and classroom work. All training is specific to the radiation sources and the equipment used. The following frame proposal is a considered a minimum for such a course:

1. Basic ionising radiation physics.
2. Detection and measurement of radiation, units.
3. Regulations
4. Biological effects from ionising radiation
5. Use of equipment – protective measures
6. Lessons learned from accidents in industrial radiography
7. Emergency preparedness
8. Exercises
9. Test of competence.

The course is considered to give satisfactory radiation protection competence for a period of 5 years. After this period or when it is considered necessary, the radiographer has to re-attend the course.

In respects of the lecturers and trainers they are appointed from the pool of experts with specialist scientific or engineering degrees nominated by various institutions. A core group of lecturers includes individuals trained according to one of appropriate training courses sponsored by International Atomic Energy Agency with graduate and post-graduate qualifications in radiation protection theory coupled with practical experience: physicist, chemists, biologist, mechanical engineers, medical doctors and legal experts. This group might include individuals available amongst "in-house" staff with specialist skills and experience as well.

4. Conclusion

Croatian legislation, the Law and regulations include a number of features, which have the potential to improve the safety the workers engaged in industrial radiography. A prerequisite for further improvement in this field is the dissemination of knowledge and ongoing commitment to training to enhance and maintain the efficiency and effectiveness of radiation protection and safety of workers.

The direction of new initiatives should not come only from the top down, as would be case with a governmental edict. Rather work should start from the bottom up so that appropriate professional groups work together to create progress. In Croatia more and more radiographers can see the results, which indicate a certain course of action. Unless information is disseminated effectively to professional groups appropriate actions will not be pursued.

It is particularly important to listen to the opinion and questions from those involved in industrial radiography and their assistants and to get some feedback from them. The usefulness and benefit of the implementation of the knowledge acquired through the training course depends mainly on their attitude and cooperation.

References

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[2] International Commission on Radiological Protection. *1990 Recommendations of the International Commission on Radiological Protection.* ICRP Publication 60. Annals of ICRP 21, No. 1-3, Pergamon Press, Oxford (1991).

[3] Food and Agriculture Organization of the United Nations, International Atomic Energy Agency, International Labour Organisation, Pan American Health Organization, World Health Organization, *International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources.* IAEA Safety Series No.115. IAEA, Vienna (1996).

[4] *The Regulation on the Conditions and Measures for Protection against Ionising Radiation for Practices Involving X-Ray Apparatus, Accelerators and Other Devices Generating Ionising Radiation.* Official Gazette No. 84/00. Narodne novine, Zagreb (30 August 2000).

[5] *The Regulation on the Conditions and Measures for Protection against Ionising Radiation for Practices Involving Radioactive Substances.* Official Gazette No. 84/00. Narodne novine, Zagreb (30 August 2000).

[6] *The Regulation on Qualifications and Education of Persons Involved in Practices with the Sources of Ionising Radiation*. Official Gazette No. 67/00. Narodne novine Zagreb (13 July 2000).

Figure 1 – Croatian infrastructure for radiation protection and associated communication network

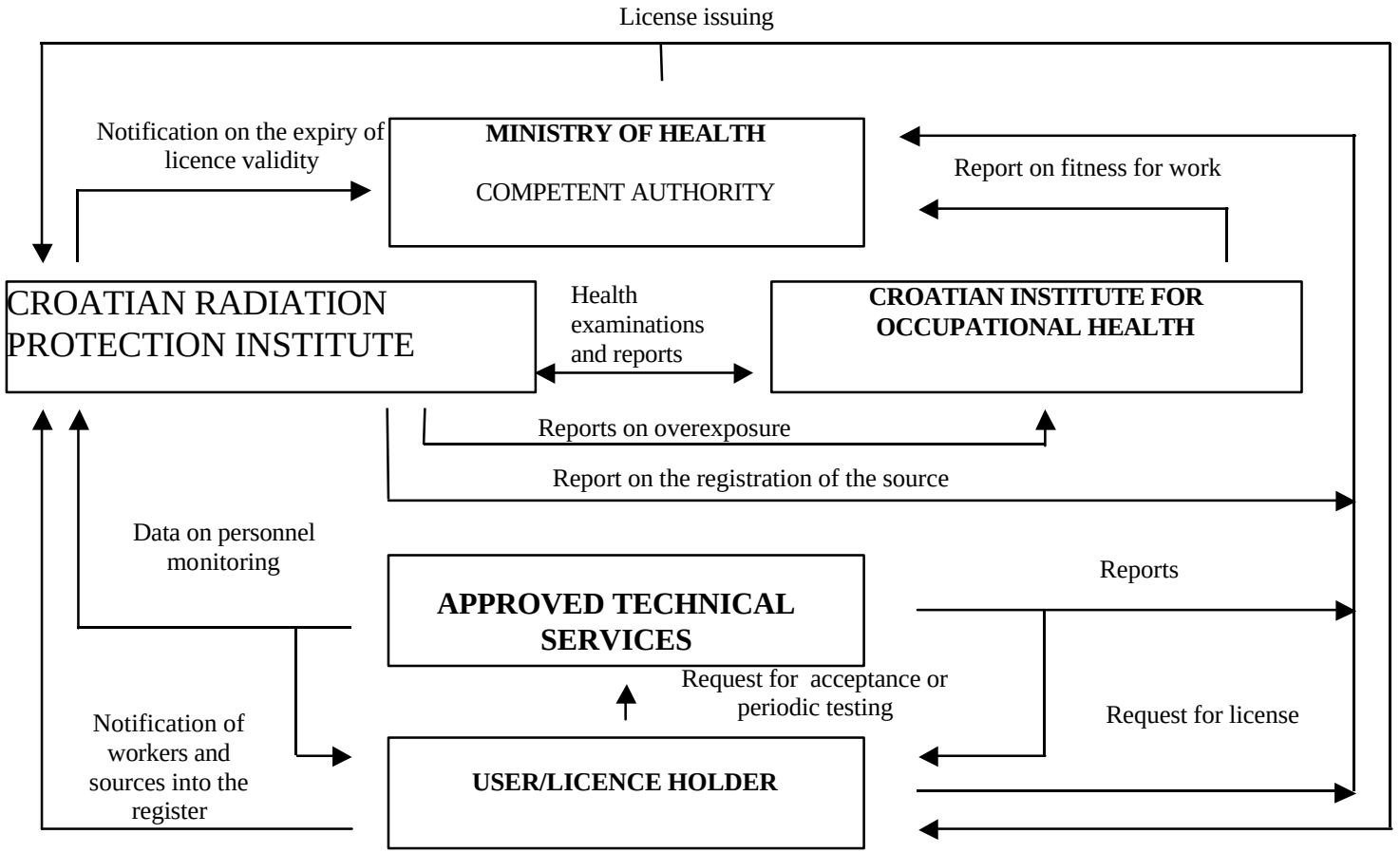

Figure 2 – Communication network for personnel monitoring system in Croatia

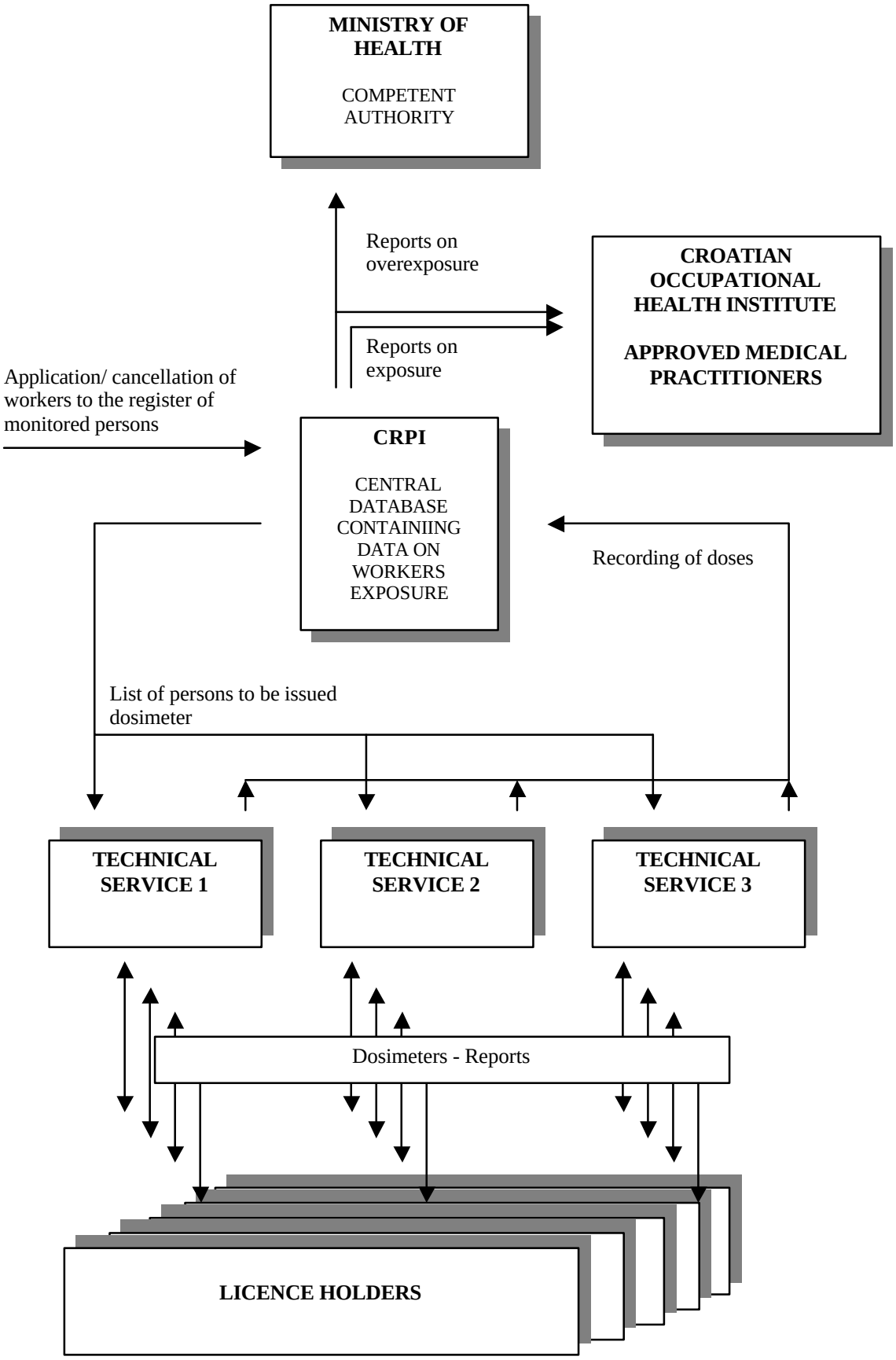

Figure 3 – Communication network for entering radiation sources into the central registry of CRPI