OVERVIEW OF DOSE RECONSTRUCTION AFTER CHERNOBYL

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The accident, which had occurred 30 years ago at Chernobyl NPP is the worst nuclear accident ever. 150,000 km2 area had been contaminated by radioactive fallout with 137Cs contamination density greater than 37 kBq m-2; a total population of these territories is about 6.4 million. Among these populations the highest exposures were received by the residents of the Chernobyl exclusion zone (often mentioned as 'the 30-km zone') and Chernobyl cleanup workers, so-called 'liquidators', not to mention children and adults exposed internally to the radioactive isotopes of iodine.
Unfortunately, individual doses of those cohorts remained unknown – were not measured by default for evacuees and were not measured/recorded due to failure of existing occupational dosimetry system to cope with the accident of excessively large scale. At the same time, doses of the members of the exposed cohorts are of great interest both from the point of view of evaluation (prognosis) of adverse effects of radiation and dosimetric support of possible medical follow-up studies. In regard to the latter, dose estimation is of particular importance, since doses to all subjects of an epidemiological study should be estimated in the same way in order to rule out any bias in risk estimates. In practice, two most common approaches are implemented in radiation risk studies – full-cohort and case-control. In the first case, doses to all cohort members (several thousands) need to be evaluated in the manner, which will rule out any bias in dose estimates. Obviously, man-power and cost considerations play significant role while designing a study and choosing methods of its dosimetric support. So, in the situation of full cohort design, individual reconstruction of doses to several thousands of subjects is not feasible – mainly because of time and labor restrictions. In the situation of case-control design, when several dozens of cases and up to five matched controls per case need to be considered, individual dose reconstruction to all subjects (cases and

controls) by a single dosimetry method with known uncertainty is quite practical.

These two distinct approaches can be illustrated by the studies among Chernobyl cleanup workers (liquidators), namely: Ukrainian-American Chernobyl Ocular Study (UACOS) and Ukrainian-American Study of Leukemia and Related Disorders among Chernobyl Cleanup Workers, which were implemented in 1993-2011 jointly by Ukrainian and U.S. researchers.

In the cohort study (UACOS), cataracts and pre-cataract changes in lens opacity were studied in 8,607-member cohort, consisting of liquidators involved into Chernobyl cleanup in 1986-1987. Dosimetric support included validation of available gamma dose records, their recalibration against single 'gold standard' (EPR dosimetry with tooth enamel) and assessment of beta dose to lens by relating beta exposure to the value of respective gamma dose.

For case-control study of leukemia, subjects were selected among 110,000-member cohort covering liquidators of 1986-1990 who currently reside in selected regions of Ukraine, each case was matched with five controls and doses were reconstructed individually (for both alive and diseased subjects) using specially designed time-and-motion method RADRUE. All together doses were reconstructed to 1,000 subjects of this study.

The presentation will focus on details of the design and implementation of dosimetric support of those two large scale epidemiological follow-up studies as well as reflect practical aspects and main findings of the retrospective assessment of internal doses, in particular in the cohorts exposed to radioactive iodine at the initial time after the accident. Though implemented for specific cohorts and exposure situation, the approaches may be valid and useful for similar follow-up studies worldwide.