The development and function of the IAEA's safeguards information system

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Only in the very early stages of IAEA safeguards was the amount of information gathered small enough to be processed and evaluated manually. It soon became evident that manual processing could not last long and that automatic data-processing would be necessary. As a first step in 1971 a semi-computerized accounting system was introduced to process reports provided to the Agency under non-NPT agreements.

The next step was the development during 1971–75 of a computer-based safeguards information system (Release 1 and 2), capable of processing and evaluating information on the design of facilities and nuclear-material accounting data for NPT-type safeguards agreements. In 1976, however, after a study of the future requirements for processing safeguards data it became evident that radical technical and organizational measures were needed to cope with the growing flow of information.

The conclusions of the study shaped the development effort. The system had to be easily maintainable and usable. The IAEA's staffing policy results in frequent changes in the professional staff. Since long-term continuity of staff is unlikely, the system had to be such that a new staff member would understand the structure and functions of the system in a relatively short time and could quickly make his contribution. To this end, and because of the limited time and resources available for the development effort, it was decided that reliable commercial and other available software which met the system's criteria would be used. The expansion of IAEA computer hardware to meet the future needs of safeguards was essential so that the design of the system should take this increased computing power into account. The design of the system would also have to allow not only for growth but for adaptability and technical changes in safeguards approaches and for changing needs for information and analysis [1]. The number of accounting and inspection as well as design and other records processed since operations began is given in the table.

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Evaluating the information

Essentially two types of analysis and evaluation are performed using information processed by the system [2]. The first is that performed for the Inspectorate and by the inspectors themselves Inspectors are helped in the planning of inspections by computer programs which calculate the statistical intervals at which samples should be taken and which study the probability of detecting missing material under a variety of assumptions. An inspection evaluation file is set up for each major facility: this file permits data on material balance and methods of measurement to be changed periodically for timely evaluations These files are updated using working papers generated in the field during the examination of facility records and during inventory verification. A portable version of this computer program is being tested for use in the field.

Verification measurements made in the field using weight, volume, and non-destructive assay equipment are usually evaluated in three steps. First the equipment is calibrated using reference materials and curve-fitting computer programs. Second is the reduction of the instrument response to a first result: this may be done by a micro-processor directly connected to the

Number of records processed by the safeguards information system

Content of data	1977 (inclusive)	1978	1979	1980	1981 (to 30 June)
Accounting data records	172 000	354 000	575 000	806 000	936 000
Inspection data records	2 000	6 000	10 000	36 000	113 500
Other data records*	6 000	10 000	35 000	158 000	137 600
TOTAL	180 000	370 000	620 000	1 000 000	1 187 100

* Records with facility design information and with development, evaluation, management, and test data.

measuring equipment, or on a portable calculator. Third, the result is then compared with the facility operator's measurement, using computer programs that calculate the measurement errors and acceptance criteria for significant differences between the measurements. Much of this evaluation is currently done at Headquarters, and the next step is to change this procedure by use of portable calculators in the field and at regional offices. Analytical samples sent to the IAEA Safeguards Analytical Laboratory (SAL)* are measured and the data evaluated at Headquarters by comparing it with the operator's measurements.

The results from field measurements and from SAL measurements are stored in working papers or the data-base management system at Headquarters or both. Further evaluation is then made by the facility officer or by Data Evaluation Services as requested, for major inventory verifications and for all inspections made in a material-balance period (campaign). This is the most complex evaluation to carry out since it involves many materials, calibrations, measurements, and the extrapolation of the measurement results to the whole inventory or material balance. All the measurement errors must be propagated together to obtain the total uncertainty and tests of significance of measurement-bias and material-unaccounted-for. Practically all this evaluation work is done on the computers at Headquarters. For reprocessing plants additional methods of evaluation are being developed for direct use on mini-computers at the facility.

Another important area that is receiving more attention is the collection, processing, and evaluation of containment and surveillance information. This includes maintaining an inventory of seals on small portable calculators and at Headquarters, the processing and evaluation of films, video-tapes and other on-site monitors such as bundle counters.

The results of all these evaluations are compiled in the Inspection Report and in Statements to Member States. Considerable effort is being spent on automating parts of the inspection report on the computer. In addition, the working papers, inspection reports, and computer programs for evaluation are gradually being developed to provide information for the second level of evaluation [3].

All these results are used at the second level of evaluation which is done for management purposes and determining safeguards policy and its effectiveness. This includes evaluating the effectiveness of each inspection activity and the safeguards approach for each type of facility. It includes manpower utilization and more effective allocation of inspection effort. The results of these evaluation activities are summarized in the annual Safeguards Implementation Report and are used by the Division of Safeguards Development to initiate system studies on more effective safeguards approaches and to develop and maintain better and more reliable equipment for use in the field.

Flexible system

The basic component of the IAEA's Safeguards Information System (ISIS) is a commercially available data-base management system. A study of such systems was undertaken, and in January 1977 the Adaptable DAta-BAse Management System (ADABAS) was obtained as a gift-in-kind from a Member State. The software for the system was developed so that the input and quality control of the accounting data, regardless of its origin, could be done in a way that made its retrieval easy.

In the Safeguards Information System, as it was developed, data arriving on a variety of carriers is fed into temporary holding areas called input buffers. Immediately upon input the appropriate records are created by the data-base management system which will maintain the life history of that block of data throughout its existence in the data-base. A major design consideration was that no data would be physically purged, but rather that a historical trail would be maintained. The purpose of the holding area or input buffer is to get the data into the machine as quickly as possible so that it may be operated upon to get it to its final form. Thus if data is not in the prescribed standard format, it is converted to this format upon its transfer from the input buffers to the data files where it will reside for the remainder of its logical existence in the data base. If for any reason data is unidentifiable, it is placed in a special file where it will be investigated by a systems analyst and corrective action taken before it is fed back into the system. Periodically, the holding area is archived, thereby ensuring that all original data is stored on magnetic tape. After the loading process, it should be noted that the data is available for use. In this sense all data received is "usable". Subsequently, the data is subjected to certain Quality Control checks, the results of which are stored with the data to indicate the "level of usability" of the data. To ensure the adaptability of the system to future needs, all data fields are variable, that is to say no inherent system limitations are built-in.

This development was achieved within the Division of Safeguards Information Treatment, created in 1977 (Fig. 1).

ISIS was developed with a view to providing centralized data processing services. Because of the growing variety of data to be processed and the limited manpower in the Division of Safeguards Information Treatment, it was decided to de-centralize some of the operations. To that end a Generalized User Load and Update System (GULUS) was developed so that users, particularly those processing only small amounts of data, could take full advantage of the integrated data-base

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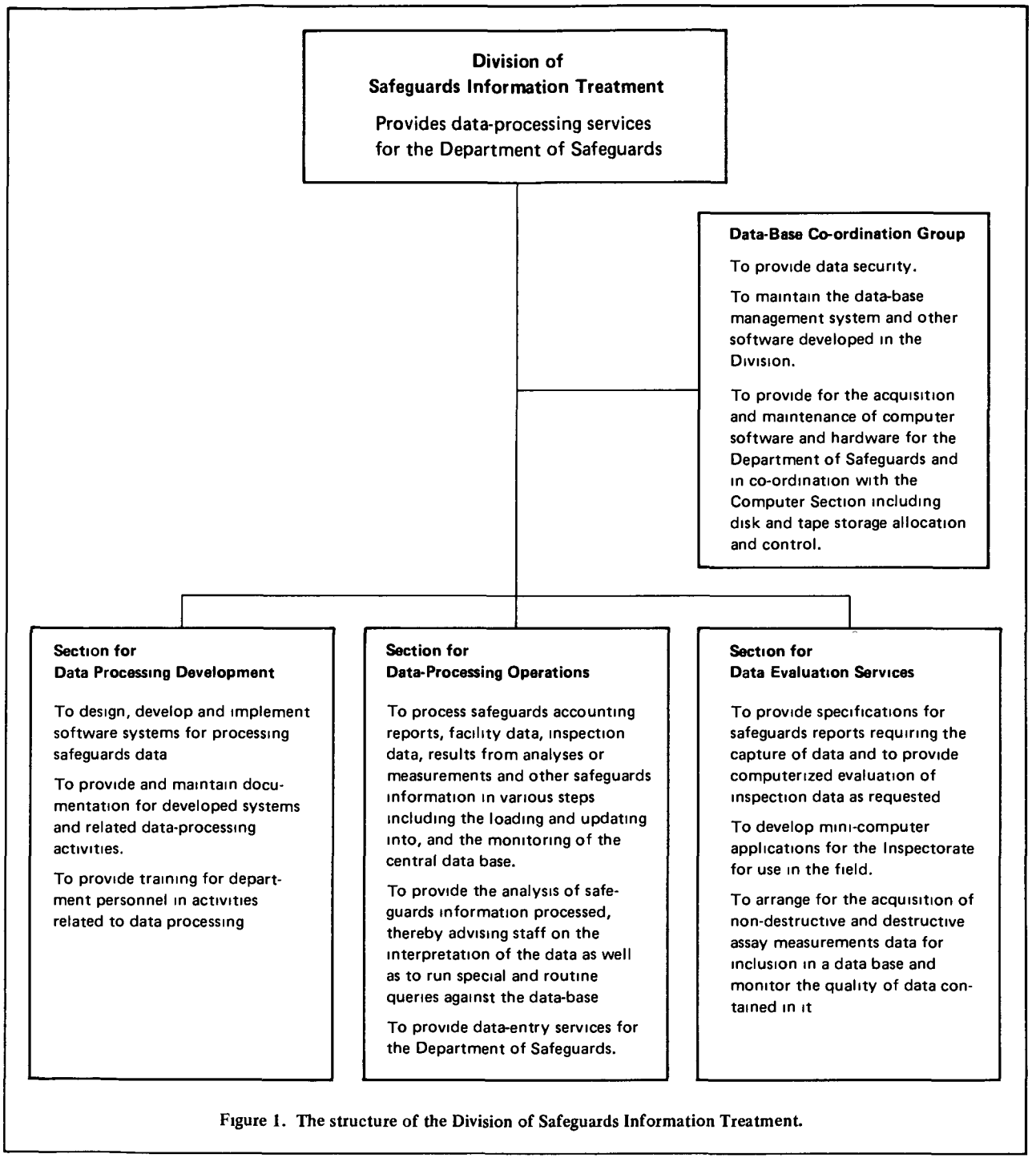

Figure 1. The structure of the Division of Safeguards Information Treatment.

design and other features. This system consists of three interacting software packages, namely:

- OMEGA: a data-entry system which provides for on-line quality control;
- GULUP Generalized User Load and Update Program, a generalized program for loading the data from an input file into the data base, and
- ADABAS. the data-base management system which manages all computerized safeguards information.

OMEGA is a formatted screen data-entry system which permits immediate intra-record quality control of the input. A user will normally use OMEGA to feed data into the computer. Data is fed into the user's workspace, using one or more screen formats. Data may be entered in batches at the user's discretion. Additionally, updates and deletions can be intermixed in any order in a batch. Each batch is written from the workspace into a separate, uniquely identified file in the OMEGA data library. Data in the OMEGA data library is available for later editing, if required.

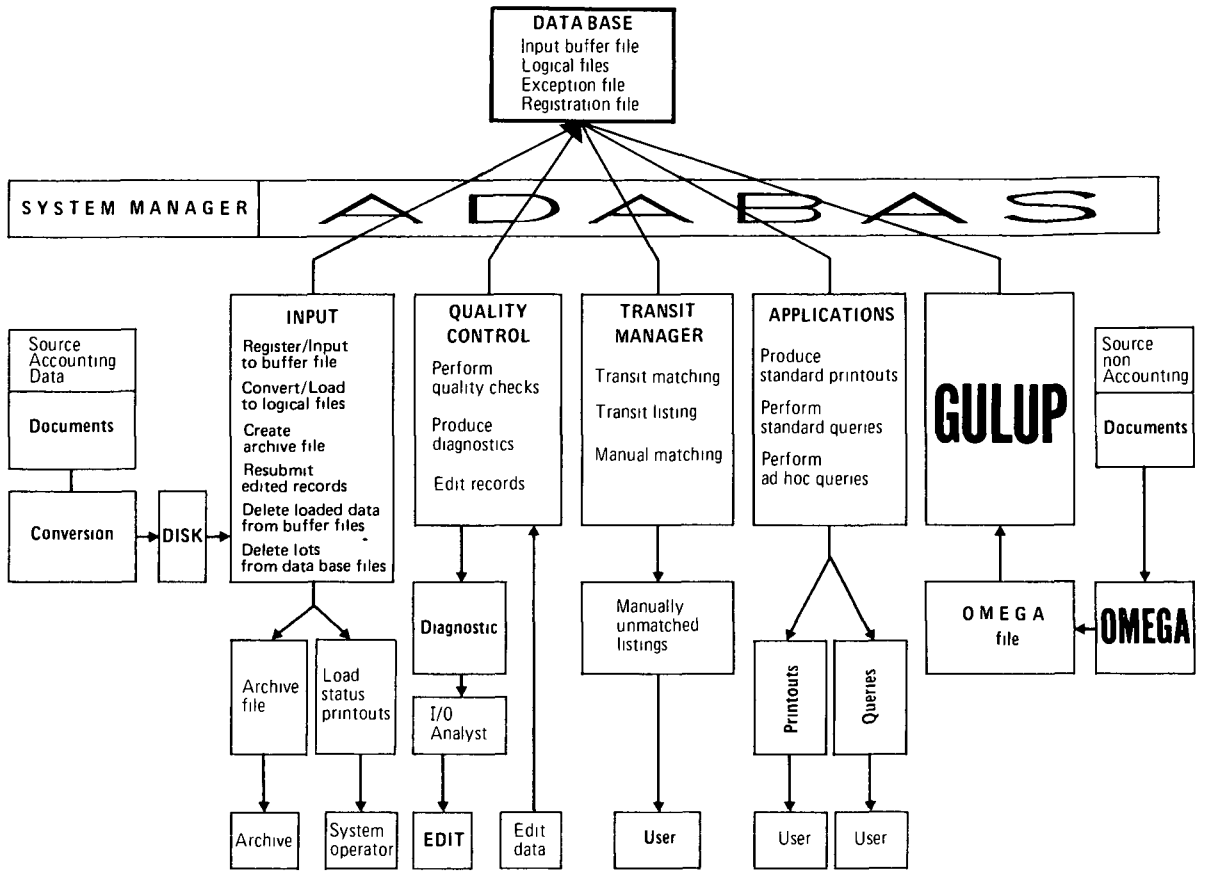

Figure 2. An overview of ISIS.

GULUP reads a completed file and loads it into the ADABAS files The loading is done on the basis of action codes which are entered with the data, and which specify whether the data is new, an update, or a deletion. After the data is loaded by GULUP into the data base, it is available to the user

The schematic view of ISIS (Fig. 2) shows the various places users can interrogate and interact with the system. This is determined by the mode of operation of ISIS and the services provided to the Inspectorate, the evaluation groups, and to the management. On top of the evaluation services mentioned below, the Division of Safeguards Information Treatment performs centrally the input of the mass-volume data, all the quality control operations – including the input and output analysis and editing of the data – the processing and analysis of the inspection plans and summaries, and the processing and analysis of the materials in transit (although further development work needs to be performed in this area). Moreover, about 90% of all routine printouts, statements and ad-hoc queries are run by the Division as a service, upon request by inspectors, for their preparations for or evaluations of inspections.

The Agency provides information to ISIS in the form of inspection working papers and reports as well as analytical results of samples taken at the facilities. There are two sources of input to ISIS, the Member States and the Agency. Data originating in the states consists mainly of accounting reports and design information. The information differs, depending on whether it is prescribed by an NPT or a non-NPT agreement. Under NPT agreements, the three main accounting reports are: Inventory Change Reports, showing changes in the inventory nuclear material, Material Balance Reports, showing the material balance based on a physical inventory of nuclear material actually present in the material balance area, Physical Inventory Listing, showing material identification and other batch information for each batch of nuclear material physically present in the facility at a given time. Under the non-NPT scheme, reporting is less structured. accounting reports must simply show the receipts, transfer out, and use of all safeguards nuclear material.

Design information is required by the Agency under both agreements. The non-NPT agreement requires a design review with the state submitting information for

the Agency to carry out its responsibility regarding safeguards The NPT model agreement, in contrast, specifies that design information in respect of each facility shall include its general character, purpose, nominal capacity, geographic location, the form, location of flow of nuclear material, the general layout of important items of equipment which use, produce or process nuclear material, a description of features of the facility relating to material accountancy, containment and surveillance, and many more such detailed requirements Design information is submitted at the time when the facility first comes under safeguards and is updated as required by operational changes.

The NPT agreement states that "the Agency shall take every precaution to protect commercial and industrial secrets and other confidential information coming to its knowledge in the implementation [of safeguards]". Furthermore, specific information relating to safeguards may be given only to such Agency staff members as require such knowledge by reason of their official duties. This obligation is of particular importance in the operation of ISIS. In order to fulfil these requirements, it was necessary to organize a security system covering all aspects of ISIS. In particular the security measures implemented are. administrative measures as contained in the safeguards manual, computer hardware measures, i.e. restricted-access areas for exclusive use by safeguards personnel, and software measures such as protection passwords and cyphering of computer files.

Further successful operation of ISIS is, of course, dependent upon the computer support derived from the Agency's central facility (IBM 3032) which also provides services for other IAEA Departments and the other UN organizations in the Vienna International Centre. The latest upgrade of this facility will provide an additional large computer (IBM 3033) dedicated to safeguards data processing. In addition, the Safeguards Department has itself acquired a powerful minicomputer which will be remotely connected to the IBM machine in the central facility. This configuration will provide the necessary environment for the planned introduction of a network of minicomputers located at regional offices and large nuclear facilities, and smaller portable processors to be used by field inspectors, to make IAEA safeguards more efficient.

References

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