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ACADEMY OF SCIENTIFIC RESEARCH & TECHNOLOGY

NATIONAL RESEARCH CENTRE

APPLIED SCIENCE AND TECHNOLOGY PROJECT

(Project No. 263-0016)

Demonstration Subproject

(Academy of Scientific Research and Technology)

THE DEVELOPMENT AND APPLICATION OF BIOGAS TECHNOLOGY IN RURAL AREAS OF EGYPT

Twelvth progress report (Pr/12)

Submitted to the JCC

by

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1- REPORT COVERAGE

This report seeks to highlight the major project activities over the period from October 1984 to February 1985. In particular it emphasizes two relevant aspects:

(1) The engineering group endeavors towards developing and demonstrating new designs.

(2) The International Biogas Conference that was held in Cairo last November.

Furthermore, the rationale for requesting a six-month extension of the project is outlined.

2- HIGHLIGHTS OF THE PRINCIPAL ENGINEERING ACTIVITIES

The engineering group continued with the regular follow-up of field digesters at three different locations (Manawat, Omar Makram, and Shubra-Kass). In addition, three new family-scale designs have been demonstrated at AlManawat, and the detailed design of the large-scale industrial unit to be attached to the animal raising activities of the Misr Aluminium Company has been completed. In the following part of this section, a summary of the recent demonstration accomplishments at AlManawat village is presented. The three new demonstration units incorporate novel design features in an attempt to improve productivity and relax the most dominant constraints. For instance in all the cases passive solar heating was included. The units were also fitted with adequate instrumentation for measuring temperatures and gas production rates to enable close performance assessment.

2/1- The Egyptian-Chinese Unit (Mahmoud Zafan Household)

The unit started operation during November 1984. The main features of the 8 m^3 active-volume digester are shown in Figure 1, and the layout of the unit is depicted in Figure 2. Though the

Best Available Document

Manawat .3 .

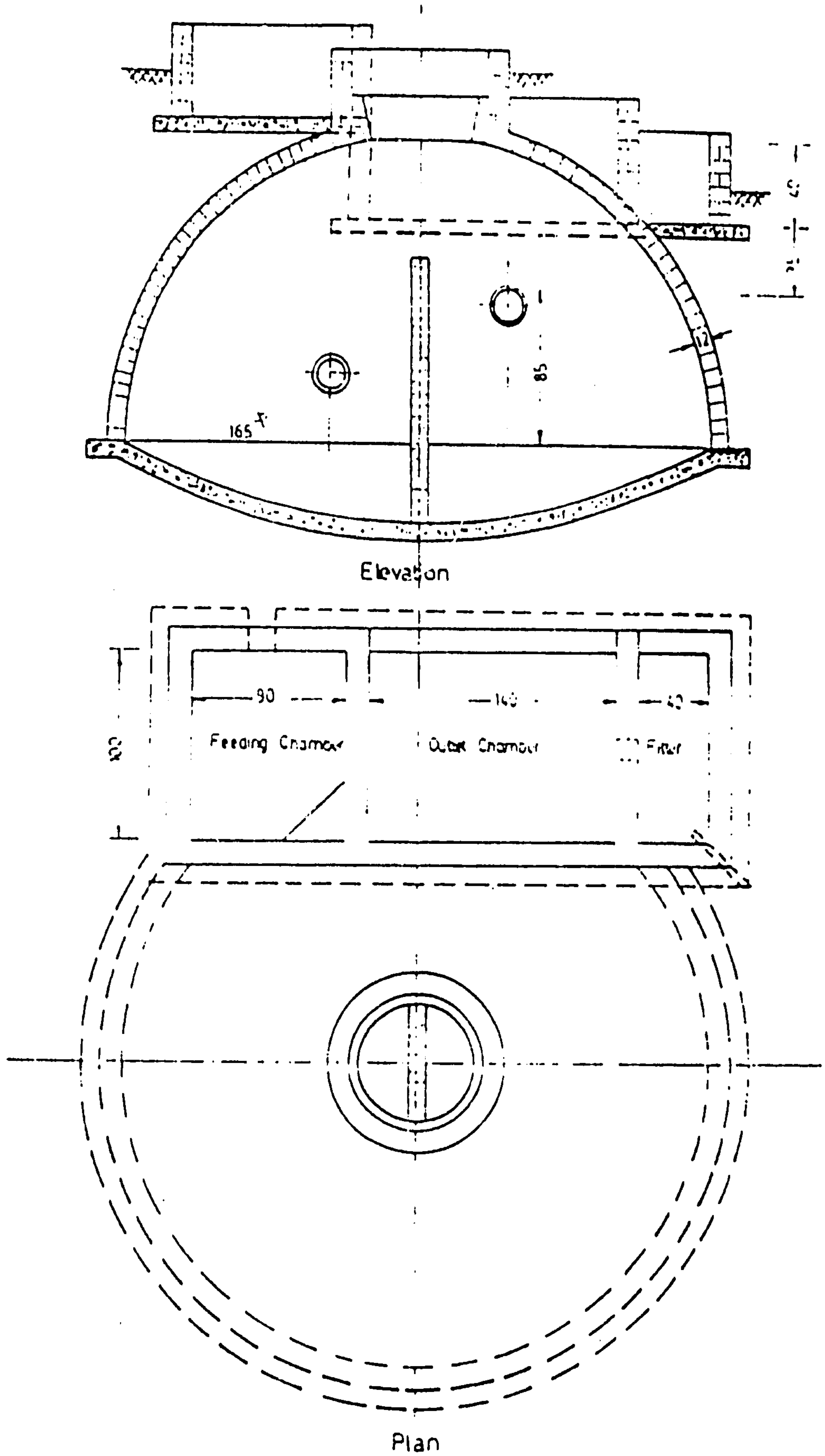

Fig. . . Egyptian-Chinese Digester (Zeetan-Meet Kados).

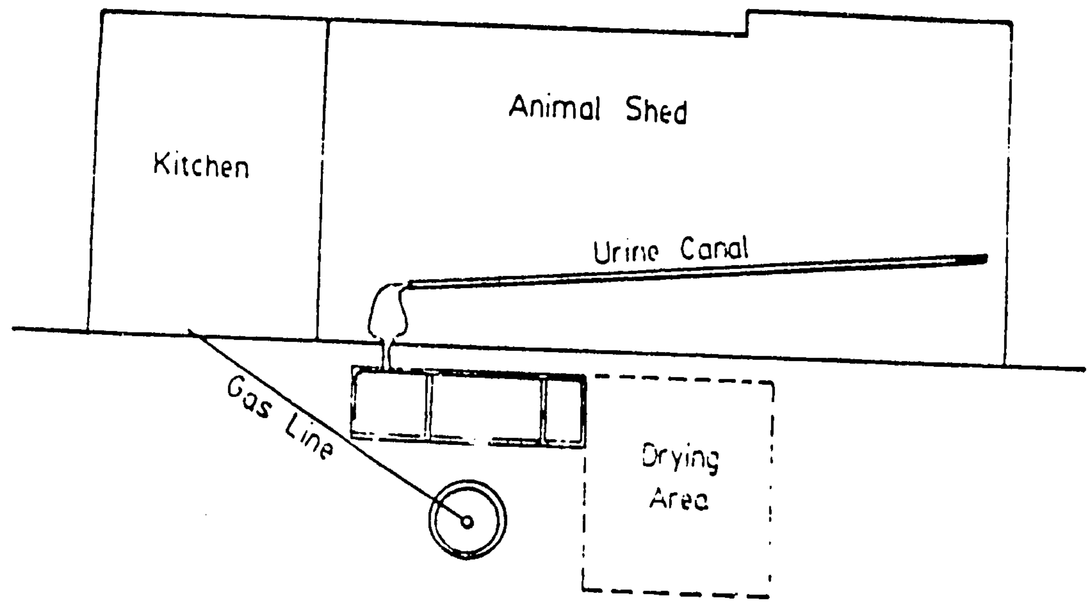

Fig. 2 . Plant layout of Egyptian-Chinese digester
(Zeefan - Meet Kados).

basic design depends on the Chinese water-pressure concept, the devised system is completely different from the traditional Chinese design. At least, the following improvements are affected:

(1) It requires less underground depth which makes it more suitable for the prevailing high water-table conditions.
(2) The system is easier, faster and less costly to build, thus is adequate for local village situations and skills.
(3) Less space is required as a result of locating both the inlet and outlet adjacent to each other and to the animall-shed wall.
(4) Partial recycle of the effluent becomes much easier on account of the adjacency of the outlet and inlet chambers.
(5) The location of the inlet and outlet chambers allows optimum slurry heating utilising both the direct green-house effect and the absorption/radiation of heat to and from the animal shed retaining wall.
(6) The new design of the outlet chamber helps in increasing the system gas storage capacity while minimizing the gas losses.
(7) The effluent flows outside automatically using the gas pressure, whereas in the conventional Chinese unit the effluent is removed through a dirty and labor-intensive manual effort.
(8) The internal baffling of the digester reduces bypassing and thus enhances pathogens-killing rate and more uniform digestion.

Preliminary performance appraisal indicates good operation and relatively high gas production rates. In fact, the family has had sufficient gas during the critical period of the winter season to cover all the household fuel requirements.

2/2- The Modified BORDA-Type Digester (Maroof Awad Family)

The 10 m^3 unit was put into operation also during November 1984. Design details are shown in Figure 3 and the unit layout is schematically presented in Figure 4.

The digester body consists of two main parts. The lower is spherical, while the upper part is cylindrical in shape and accomodates the movable metallic gas holder.

Manawat .4.

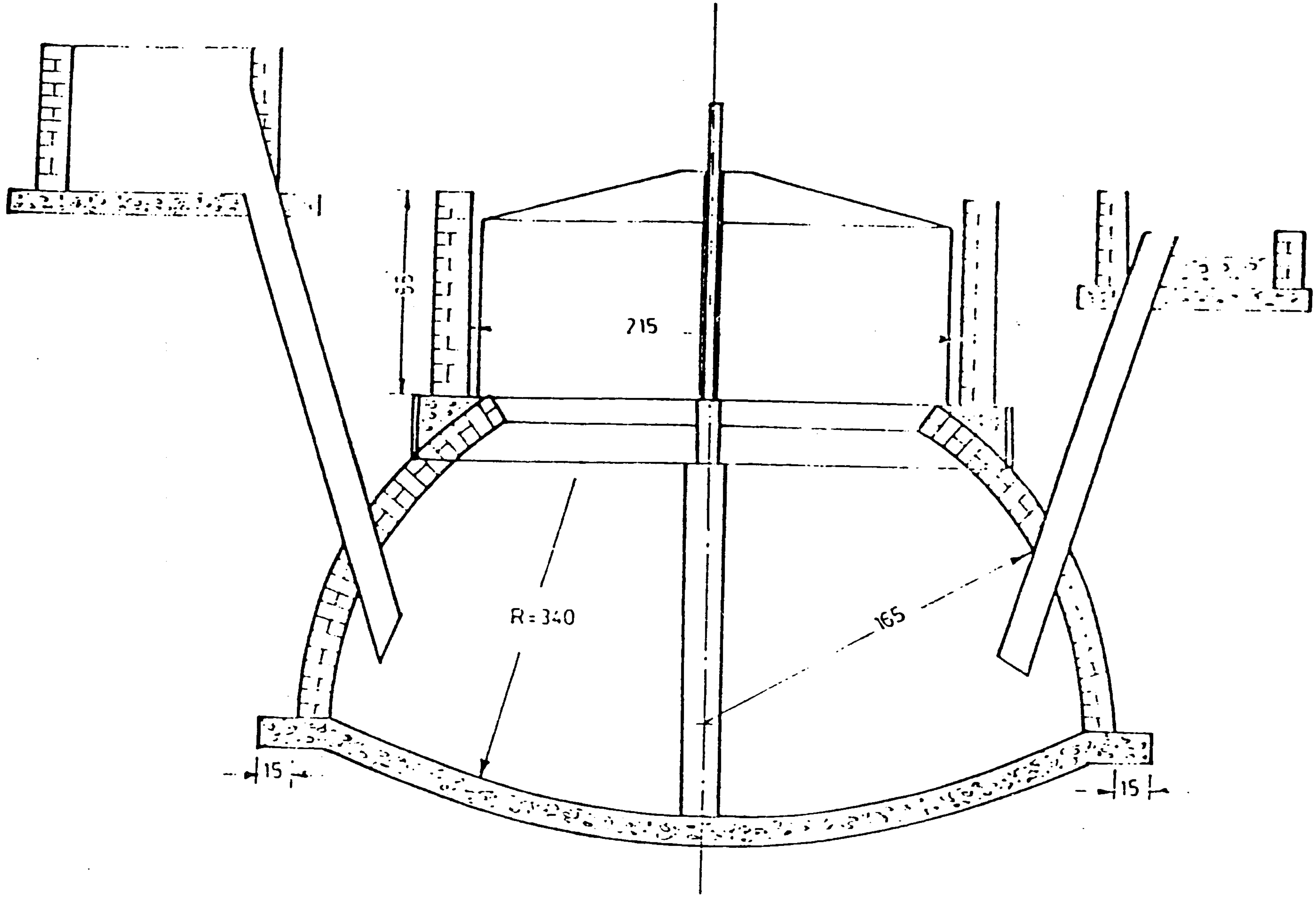

Fig. 3 . Modified Two-Chamber Borda Type Digester (Maroof-Meet Kados).

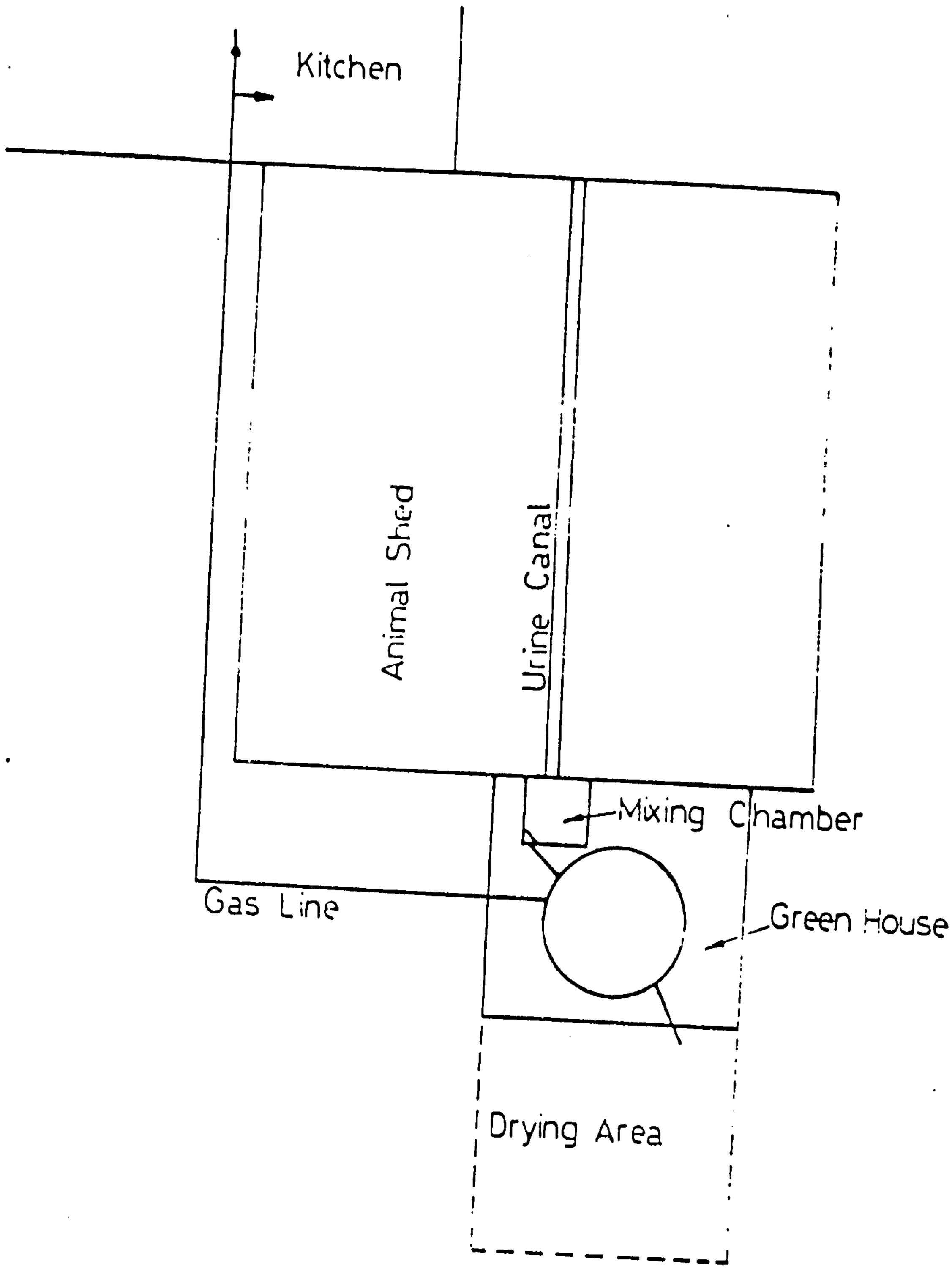

Fig. 4 . Plant Layout of the Borda Type Digester (Maroi-Meet Kados).

This type of unit can be considered as a modified version of the Indian design, whereby the lower part resembles the Chinese shallow and wide model. The cost of the unit proved to be lower than an equivalent Indian type though it would be more suitable for the Egyptian conditions (of comparatively lower ambient temperature and higher water table than the Indian case).

Initial tests of the unit indicate satisfactory performance as well as sufficient gas production for the family requirements.

2/3- The Two-Compartment Tunnel-type Digester (Abdel Rahman Awad Family)

This new type was designed to suit both high water table locations and large size installations. As a matter of fact, it was intentionally implemented as a small model to test many of the design features incorprated in the unit engineered for Misr Aluminium Company.

Digester details and unit layout are shown in Figures 5 and 6. The digester is about 13 m^3 in volume and consists of two compartments. The first is rectangular with a pyramid-shaped fixed roof; while the second compartment is circular and houses the movable metallic gas holder.

New systems for scum containment, mixing and breaking are installed for evaluation. These include a metallic screen located 10 cms. below the uppermost level of the slurry in the first compartment to act as a scum strainer, thus preventing its flotation and at the same time enhances its digestion. Also, in the gas holder located in the second chamber, an incomplete cone is welded inside the digester to assist in the desired outcome of scum breaking and mixing. Another feature worthy of mention is that the first compartment of the digester is covered by a reservoir which act as a solar pond for heating the unit and for producing warm water for the daily feed.

The construction of the unit has been recently accomplished and it is being tested at the time of preparing this report. Start-up is scheduled during the first week of March [illegible].

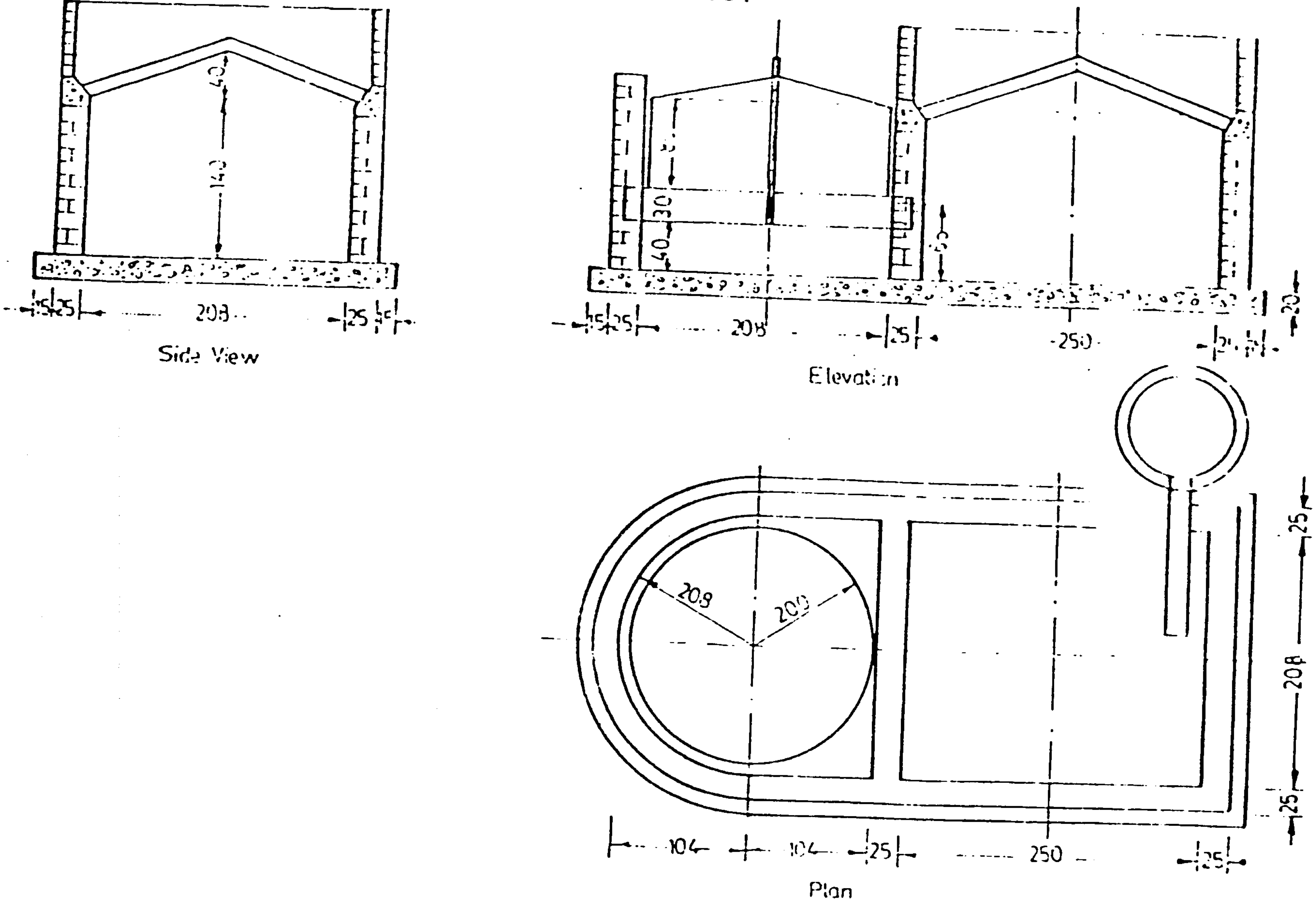

Fig. 5 . Two-Chamber Tunnel-Type Digester (Rahman - Meet Kados) .

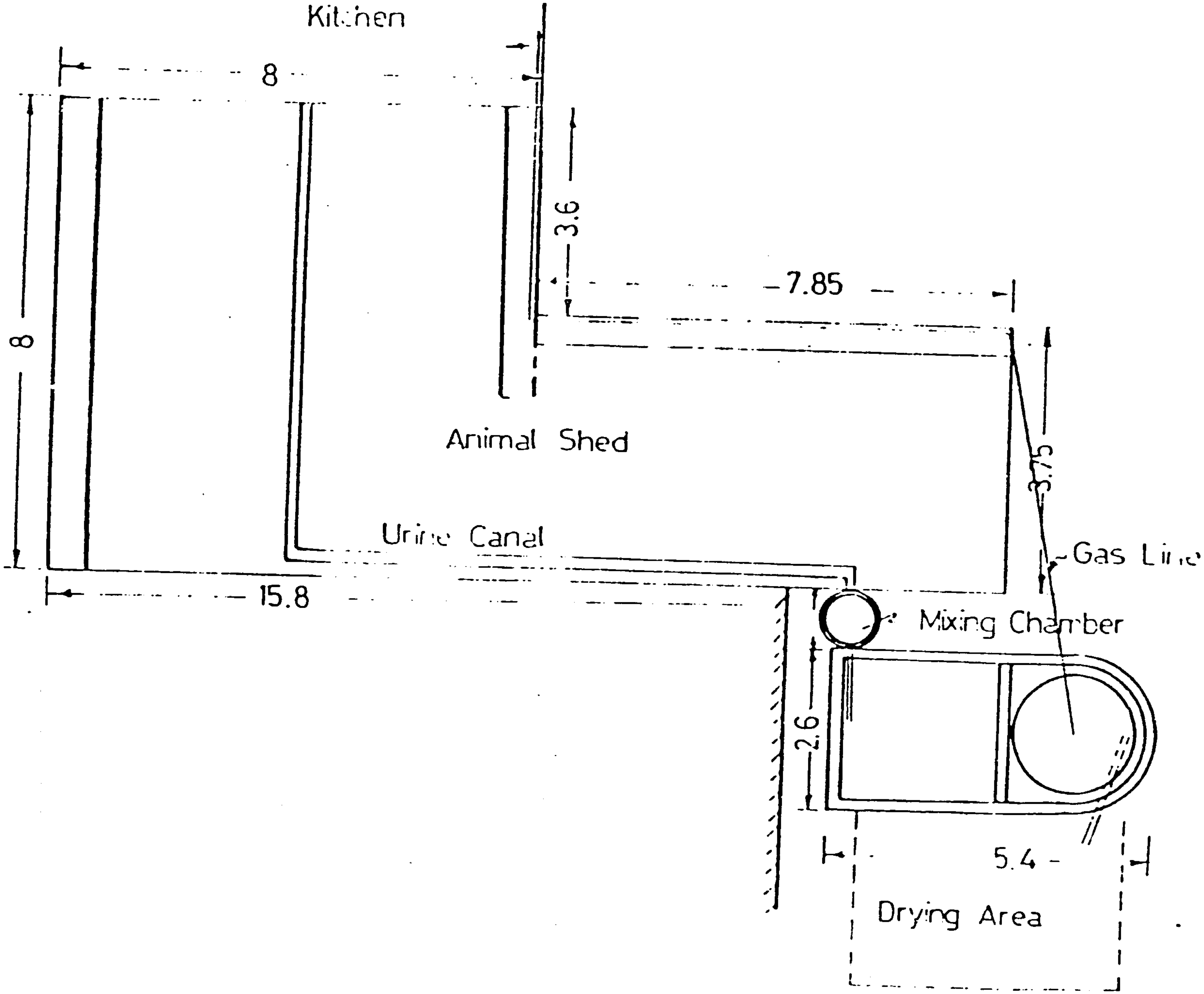

Fig. 6 . Plant layout of the two-chamber tunnel-type digester (Rahman, Mat Kadar)

3- THE CAIRO BIOGAS CONFERENCE

3/1- Organizers and Participation

The Conference was organized by the Egyptian Academy of Scientific Research and Technology (ASRT), the Egyptian National Research Centre (NRC), the Bioenergy Systems and Technology (BST) of the U.S.AID Office of Energy, and the National Academy of Sciences (NAS). A number of International organizations and agencies (FAO, USAID, GATE/GTZ, ICAITI, IFS, OLADE, CERES) are co-sponsoring the Conference. Over 100 participants from 37 countries attended. The Conference was held in Cairo , Egypt during the period from November 17 to 24 1984 and was officially inaugurated by H.E. Prof. M. Kamel, President of the ASRT on behalf of H.E. Prof M.K. Helmy, Deputy Prime Minister and Minister of Higher Education and Scientific Research.

3/2- Purpose

To assess the viability of the Biogas Technology (BGT) and propose optimum future courses of action for exploiting the BGT prospects to the fullest extent.

3/3- Scope

The Conference emphasized a balanced coverage of technical, environmental, social, economic and organizational aspects relevant to biogas systems design, operation and diffusion. It has been organized to incorporate experiences that are pertinent in most part to developing countries.

101 papers were presented. They can be classified roughly according to the following:

6 General topics and overviews.

19 Engineering designs.

2 Gas-use devices.

16 Bioconversion and digestibility Studies.

4 Use of digested materials as fertilizer.
5 Control of pathogens.
3 Socio-cultural aspects.
4 Economic aspects.
8 Regional programs, networks and aid agencies.
34 Country programs and projects.

In addition, institutional and infrastructural aspects were covered through moderately structured brainstorming sessions.

3/4- Project Contributions

Aside from the fact that the Conference concept and organization were predominantly the Project responsibility, 17 papers were contributed by Project personnel. In many sessions the project Contributed papers represented key presentations. A list of these papers is given in the following:

1- Introduction and overview. M.M. ElHalwagi, NRC, Egypt.

2- Force field analysis of biogas systems and proposed means for optimising their prospects. M.M. ElHalwagi, NRC, Egypt.

3- Design parameters affecting success and failure of biogas systems. M.A. Hamad, A.M.Abdel Dayem and M.M. ElHalwagi, NRC, Egypt.

4- Study of the Optimum operating conditions for the anaerobic digestion of some organic wastes. Sh. I. El-Shawarby, N.A. Shabaan, F.El-Gohary and M.M. ElHalwagi, NRC, Egypt.

5- The assessment of methanogens by the quantitative determination of coeenzyme F_{420} in anaerobic systems. I. Extraction and spectrofluorometric studies M.E. Abdel-Samie, NRC, Egypt.

6- The toxicity effect of pesticides and herbicides on the anaerobic digestion process. F.A. El-Gohary, F.A. Nasr and D.A. Aly, NRC, Egypt.

7- The assessment of cellulolytic activity in anaerobic digesters by the "textile coupon technique", M.E. Abdel-Samie, and M.H. Mahmoud, NRC, Egypt.

8- Assessment of anaerobically digested slurry as a fertiliser and soil conditioner. H.Moawad, L.I. Zohdy, S.M. Bader El-Din, M.A. Khalafallah and H.K. Abdel Maksoud, NRC, Egypt.

9- Repeated application of biogas slurry and its effect on the yield and NPK uptake of wheat, turnips and onion plants. L.I. Zohdy, R.A. Abd El-Aziz, M.H. Enany, A.S. Turky and S.M.A. Radwan, NRC, Egypt.

10- Health risks associated with the use of slurry. M.A.A. Tawfik, NRC, Egypt.

11- Incidence, persistence and control of parasitic eggs and cysts in anaerobically digested wastes. M.A. Tawfik, M.A. Hassanain and N. Sh. Deghidy, NRC, Egypt.

12- Incidence, persistence and control of some pathogens during anaerobic digestion of organic wastes. Part 2. Salmonella, Shigella, atypical Mycobacteria and Clostridia. M.A. Tawfik, A.G. Hegazi, H.Soufy and L.Ali, NRC, Egypt.

13- Health aspects of energy production from biomass. M.M.El-Abagy, S.El-Hawary, H.T. El-Zantaly and F. Nasr, NRC, Egypt.

14- Social, Ecological, and Cultural Realities of Biogas Development H.R. Capener N.Y. state College of Agriculture and life Sciences USA, and M.M. ElHalwagi - Pilot Plant Lab-NRC, Egypt.

15- Assessment of the feasibility of Rural Biogas Systems. M.M. ElHalwagi, NRC, Egypt.

16- Development and application of biogas technology for rural areas of Egypt-The National Research Centre Project. M.M. ElHalwagi, A.M. Abdel Dayem and M.A. Hamad, NRC, Egypt.

17- Team advising of Egyptian biogas research project. P.R. Goodrich.

3/5- Major Conference Conclusions and Recommendations

A 13 page preliminary draft 'executive summary' was prepared by the end of the meetings to highlight the major Conference findings and recommendations. The following constitute a very concise extract:

A- General

A.1- BGT has a potential for providing fuel, fertilizer and a sanitary means of waste disposal in the rural areas.

A.2- Despite the fact that the technique is proven and the benefits are aplenty, digesters have had a disappointingly low success rate in many developing countries. Poor economics may explain these failures in some cases; but poor fits between digesters and local conditions - a lack of appropriateness - coupled with the unability of putting the technological package together and keeping it so - can also be very relevant indicators.

A.3- There is no simple formula to develop a reliable biogas scheme that satisfies the basic requirements of being a properly integrated technical system having the appropriate multi-fits to the household/farming systems as well as the village surroundings and that fills real perceptible needs at an affordable cost. Such demanding requirements call for strong government support coupled with a whole set of logistic measures covering the technical, social, financial and institutional aspects.

B- Technical Considerations

The following areas were identified as needing further work.

B.1- Basic research in the relevant fields of microbiology, biochemistry and advanced reactor design.

B.2- Development of appropriate digesters and optimization of promising designs like batch (dry fermenters) and plug-flow digesters.

B.3- Standardization of data collection and reporting throughout the world to enable useful comparisons and utilization.

B.4- Digestion of wastes other than animal manure, for example: agricultural residues, aquatic plants and agro-industrial wastes.

B.5- Fertilizer evaluation and pathogen-kill rate.

B.6- Heating and mixing of digesters.

B.7- Optimization of gas-use devices.

C- Economic Facets

C.1- The economic contribution of biogas to national energy is likely to be small (~ 1-10%). However, in rural areas, it may be substantial (~ 50%), and should not be dismissed lightly as it could considerably reduce the burden of life in these areas.

C.2- The key to the economic viability of biogas lies in maximizing the use of all its outputs and not just in the energy content of the gas.

C.3- Feasibility assessments should consider both financial analyses and social cost-benefit appraisals.

C.4- Economic viability increases with the scale of application. Large units, such as community scale and plants attached to animal rearing operations are normally more viable.

C.5- Many developing countries extend subsidies on energy and fertilizers. Such subsidies induce economic distortions and negative impacts on the viability of biogas systems. Redirection of these subsidies to renewable energy sources like BG systems can be of considerable national benefit.

D- Social and Institutional Aspects

D.1- Successful biogas programs require interdisciplinary approach.

D.2- BGT diffusion calls for understanding and assessing user needs. Its success depends on the proper examination of the following crucial questions:

- What types of institutional infrastructure are best suited to support and sustain a broad-scale program of biogas development?
- How can the multi-institutional, multi-purpose and multi-disciplinary features of BGT development be properly managed?

- o Are there appropriate and useful rules for private voluntary organizations, for cooperatives and for the private sector?
- o Should powers od adminstrative oversight of a biogas program be placed high enough in the government adminstration to facilitate coordination between concerned ministries and special interest groups?

In conclusion, the Conference noted that BGT is a viable option in developing countries to mitigate some of the more pressing problems they face such as energy, public health and agricultural productivity. However, it was accepted that it is not the only option available and more work and thought is needed to closely define the conditions where biogas is the optimum choice for the policy maker.

4- RATIONALE FOR PROJECT EXTENSION

A request has been officially made to extend the project till October 1985 for the following reasons:

(1) Allow completion of the biogas basic infrastructure within the NRC biomass extension and training area. Sufficient funds (in Egyptian Pounds) are already existing within the project budget for this purpose. The NRC biomass site will constitute a very important base for future interdisciplinary developments and interactions in the broader field of solid waste management, treatment and resource recovery. The biogas project principal investigator is also the principal investigator of the NRC biomass program which includes: biogas, gasification, development of improved rural stoves and ovens, urban solid waste management and so many other related ancillary and support activities.

(2) To permit proper accomodation and installation of phase 2 equipment. None of these equipment has been received as yet; though ordered since 1981. It seems, however, that orders for most of these equipment have already been placed and even some has already been dispatched.

(3) To review, edit and publish the Conference proceedings.