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INTERNATIONAL ENERGY AGENCY (IEA)

ENERGY CONSERVATION THROUGH ENERGY STORAGE (ECES)

ANNEX XX: Thermal Response Test

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1. Background and Scope

Thermal Response Test (TRT) is a measurement method to determine the heat transfer properties of a borehole heat exchanger and its surrounding ground in order to predict the thermal performance of a ground-source energy system. The two most vital parameters are the effective thermal conductivity of the ground and thermal resistance within the borehole. The TRT equipment is usually mounted on a trailer for easy transportation to test sites. This method has been very important in the rapid spreading of BTES systems. It has been a door opener for introducing the technology in "new" countries.

The first paper suggesting the mobile TRT method was presented at the "Stock" Conference in Stockholm in 1983. It took until the mid 90ies until TRT was developed, independently in US and Sweden, and the first mobile TRT equipment was operated in 1996 in Sweden. The technology has since spread to about 20 countries in Europe, Asia, North America and South America and will soon be introduced in Africa. Since the TerraStock Conference in Stuttgart 2000, TRT has had a special session at the Stock Conferences.

There are basically two ways to operate the TRT equipment; for heat injection or heat extraction in the tested borehole. There are also systems in which both modes are available. The size and shape of such equipments varies from suitcase to caravan.

The first step of the test is to determine the undisturbed ground temperature. This is usually made by temperature logging in the borehole, or by evaluating the fluid temperature of the circulating fluid before the heating/cooling is switched on.

The measured thermal response is the temperature change of the inlet and outlet temperatures. Superimposed temperature fluctuations usually depend on the varying ambient air temperature or corresponding fluctuations in the power supply to the circulation pump. Air temperature and the power consumption are therefore often measured to separate such disturbances in the evaluation.

Used evaluation methods are: the Line Source Model, which is commonly used in Europe and Numerical Simulation Models which are more often used in North America.

2. Objectives

The overall objectives of Annex XX are to compile TRT experiences worldwide in order to identify problems, carry out further development, disseminate gained knowledge, and promote the technology. Based on the overview, a TRT State of the art, new developments and further work are studied.

The Specific Objectives of Annex XX are:

Overview

- Worldwide use of TRT (country, type, number)
- Purpose of test (design values, research & development, quality control / failure analysis).
- Applications (BHE, energy piles, heat pipe BHE's, etc.)
- TRT method (heating and / or cooling)
- Experimental setup (monitoring accuracy, etc.)
- Test procedure
- Evaluation models

New Developments and Further work

- Method to determine undisturbed ground temperature
- Swiss method for detailed logging of borehole temperature – swimming data acquisition 'Fisch', etc.
- Groundwater influence
- TRT while drilling
- Software for automatic evaluations
- Comparison of equipment and evaluation
- Initiate a common quality standard of TRT worldwide
- Invitation to „new“ countries – workshop and courses on how to use TRT

3. Means

Countries participating in the IEA R&D Program perceive collective benefits from sharing R&D results from national programs and from collaborative international R&D. Therefore, the means employed to achieve Annex XX objectives will be collaborative efforts based upon co-operation and task sharing arrangements with lead countries for each sub-task.

4. Activities

Figure 1 shows the flowchart for the activities that will be performed in the subtasks.

Sub-task 1. TRT state-of-the-art

- Conduct a state-of-the-art survey covering worldwide use including TRT types, purpose, applications, experimental setup, test procedure and evaluation models

Sub-task 2. New Developments

- Method to determine undisturbed ground temperature
- Groundwater influence
- TRT while drilling
- TRT for special geometries like energy piles
- The Swiss Fish method etc.

Sub-task 3. Evaluation methods and developments

- Comparison of equipment
- Comparison of test procedure
- Comparison of evaluation methods
- Software for automatic evaluations

Sub-task 4. Standard TRT Procedures

- Initiate a worldwide TRT standard – best practice

Sub-task 5. Dissemination Activities

- Invitation to „new“ countries – workshop and courses on how to use TRT
- Common website of compiled TRT information

5. Responsibilities of Participants

Experts' Meetings will be rotated among the participating countries to the extent feasible. A Lead Country will be responsible for each sub-task.

Participants are expected to contribute equally to the completion of the Annex in terms of collaborative effort. The Executive Committee may decide that one or more Participants may contribute to the Annex in part with budgetary resources in lieu of collaborative effort on certain tasks.

Associate memberships in the Annex are encouraged under arrangements agreeable to by the participating countries and the consent of the Executive Committee.

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6. Responsibilities of the Operating Agent

Sweden, represented by Luleå University, will provide the Operating Agent. The Operating Agent shall be responsible for overall management of the work under Annex XX and for implementing the decisions of the Executive Committee. To that end, the Operating Agent shall

- initiate and plan Experts' Meetings to accomplish the objective of the Annex;
- prepare work plans for the Annex to accomplish its objectives;
- co-ordinate the publication and dissemination of intermediate reports as required;
- report to the Executive Committee on the results and progress of the work under this Annex, at least semi-annually, or as required;
- on completion of the Annex, compile and distribute to all participants a final report on the Annex.

7. Results

The results of this annex will be:

- A TRT state-of-the-art survey. This survey will help determine the need and direction of further R&D. The "State of the Art Report" will be published as an IEA technical document.
- Periodic documents and interim progress reports
- A final report describing the work carried out under this Annex.
- Best Practice TRT Manual
- Information database on a website.

8. Time Schedule

The Annex will run for 36 months from 2007 until 2010.

9. Level of Effort

Participants are expected to contribute equally to the completion of the Task in terms of work sharing. All activities need to be documented. The lead country for each phase will be responsible for the editing, printing and distribution of activity reports.

Expert Meetings will be called by the Operating Agent with the advice of Experts so as to accomplish the objectives of the Annex. Activity meetings may be called by lead countries with the agreement of the Operating Agent. The Operating Agent is urged to employ advanced communications techniques to enhance communications among participants between meetings. A rough guide to the number and frequency of full Experts' Meetings is on to two such meetings per year over the life of the Annex.

It is expected that the level of collaborative effort required to complete the work of this Annex is 3 person-months per country per year and 3 months per year for the Operating Agent.

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10. Participants

According to the results of the Executive Committee meeting at Stockton, N.J. USA, 1 June 2006 the XC delegates from Canada, Netherlands, Norway, Turkey, Japan, Sweden, Belgium, and Germany showed interest to participate. The final decision of participating countries will be made at the Executive Committee Meeting.

11. Information and Intellectual Property

Executive Committee's Powers

The publication, distribution, handling, protection and ownership of information and intellectual property arising from this Annex shall be determined by the Executive Committee, acting by unanimity, in conformity with this Annex.

Right to Publish

The Participants shall have the right to publish all information provided to or arising from their Task, except proprietary information, as defined below.

Proprietary Information

The Participants and the Operating Agent shall take all necessary measures in accordance with this paragraph, the laws of their respective countries and international law to protect the proprietary information provided to or arising from this Task.

For the purposes of this Annex, proprietary information shall mean information of a confidential nature such as trade secrets and know-how (for example, computer programs, design procedures and techniques, chemical compositions of materials, or manufacturing methods, processes or treatments) which is appropriately marked provided that such information:

- Is not generally known or publicly available from other sources;
- Has not previously been made available by its owner(s) to others without obligation concerning its confidentiality; and
- Is not already in the possession of the recipient Participant(s) without obligation concerning its confidentiality.

It shall be the responsibility of each Participant supplying proprietary information, and of the Operating Agent, to identify such information as proprietary and to ensure that it is appropriately marked.

Production of Relevant Information by Governments

The Operating Agent should encourage the governments of all Agency Participating Countries to make available or identify to the Operating Agent all published or otherwise freely available information known to them that is relevant to the Task.

Production of Relevant Information by Participants

Each participant agrees to provide to the Operating Agent all previously existing information, and information developed independently of the Task, which can assist or is needed by the Operating

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Agent to carry out its functions in this Task, which is freely at the disposal of the Participants, and the transmission of which is not subject to any contractual and/or legal limitations, under the following conditions:

- If no substantial cost is incurred by the Participant in making such information available, at no cost to the Task therefore;
- If substantial costs must be incurred by the Participant to make such information available, at such charges to the Task as shall be agreed between the Operating Agent and the Participants with the approval of the Executive Committee.

Use of Confidential Information

If a Participant has access to confidential information which would be useful to the Operating Agent in carrying out the studies, assessments, analysis or evaluations called for in this Task, such information may be communicated to the Operating Agent but shall not become part of any report or other form of documentation issued as part of this Task, nor shall it be communicated to the other Participants, except as may be agreed between the Operating Agent and the Participant who supplies such information.

Acquisition of Information for the Task

Each Participant shall inform the Operating Agent of the existence of information that can be of value to the Task, but which is not freely available, and each Participant shall endeavor to make such information available to the Task under reasonable conditions, in which event the Executive Committee may, acting unanimity, decide to acquire each information.

Reports on Work Performed under the Task

The Operating Agent shall provide reports on all work performed under the Task and the result thereof, including studies, assessments, analysis, evaluations and other documentation, but excluding proprietary information.

The reports are open for the participants, for the distribution of the reports to non-member countries an embargo of one year after finishing the Annex has been agreed.

Copyright

The Operating Agent, or each Participant for its own results, may take appropriate measures necessary to protect copyrightable material generated under this Task. Copyright obtained shall be the property of the Operating Agent, for the benefit of the Participants provided, however, that Participants may reproduce and distribute such material, but shall not publish it with a view to profit, except as otherwise provided by the Executive Committee.

Author

Each Participant shall, without prejudice to any rights of authors under its national laws, take necessary steps to provide the co-operation from its authors required to carry out the provisions in this paragraph. Each Participant shall assume the responsibility to pay awards or compensation required to be paid to its employees according to the laws of its country.

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12. Responsibilities for Sub-tasks

SUB-TASKS	LEAD COUNTRY
1. TRT state-of-the-art	Sweden?
2. New TRT Developments	Norway or Belgium?
3. TRT Evaluation methods and developments	Netherlands or US?
4. Standard TRT Procedures	Germany?
5. Dissemination Activities	Sweden?

Suggested lead countries are not yet decided

13. Workplan

The Annex XX Workplan and time schedule for annex activities are shown in Table 1. Most activities will be carried out during a 12 month calendar period. It is assumed that the state-of-the-art report and also new TRT developments should be updated during the last year of the project.

ACTIVITY	2007	2008	2009	2010
Annex Meetings	X X	X	X	X X
Phone Meetings	X ?	X ?	X ?	X
1. State-of-the-art	X----- -	----X	-----	-----
2. New TRT Developments	X-----	-----X	-----	-----
3. TRT Evaluation methods and developments		X-----	----X	
4. Standard TRT Procedures			X-----	-----X
5. Dissemination Activities		X	-----	-----X