CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Trip to Atomic Energy of Canada, Limited Whiteshell Laboratories (20.01402.871)

DATE/PLACE: June 27, 2000
Pinawa, Manitoba

AUTHOR: David R. Turner

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PERSON(S) PRESENT:

In addition to the author, D. Campbell [(U.S. Department of Energy (DOE)] and W. Seddon Atomic Energy of Canada, Limited (AECL) visited the AECL Whiteshell Laboratories near Pinawa, Manitoba.

BACKGROUND AND PURPOSES OF TRIP:

Unsaturated zone (UZ) flow and transport is one of the principal factors DOE is relying on in its Repository Safety Strategy (RSS) (U.S. Department of Energy, 1999). Transport through fractured rock and transport through porous rock are two of the subissues in the Radionuclide Transport (RT) Key Technical Issue (KTI) to evaluate this portion of the DOE safety case. Of particular interest in resolving these two subissues (Nuclear Regulatory Commission, 1999) is the use of field scale experiments, and establishing the effectiveness of using nonradioactive tracers (Li, Br) as analogs to radioelements of concern (Tc, Np) in repository performance.

For the past several years, the DOE has conducted a series of UZ tracer tests at an underground test facility at Busted Butte, Nevada. DOE selected the location of the facility partly because the Topopah Spring and Calico Hills tuffs, stratigraphic units that are expected to provide natural barriers at the proposed repository, are present in a thinner section and are closer to the surface and more accessible at Busted Butte. The field scale tracer tests at Busted Butte are carried out with a suite of reactive and conservative nonradioactive tracers such as Li and Br intended to be illustrative of radionuclide migration in the UZ. Nonradioactive tracers are used because of the potential environmental problems with intentionally introducing radionuclides in the field.

An additional task using blocks of nonwelded tuff collected at the Busted Butte facility is currently being conducted at AECL/Whiteshell in Pinawa, Manitoba. Tests are planned using a cocktail of radioactive tracers such as neptunium, technetium, cobalt, cesium, tritium, and sodium. AECL staff have experience conducting large block tracer tests in fractured granite as part of the Canadian Nuclear Waste Program.

SUMMARY OF PERTINENT POINTS:

D. Turner from the CNWRA visited the AECL facilities on June 27, 2000 to observe progress in the large block tracer tests. In addition, AECL staff made presentations on the history and current state of the

Canadian High-Level Radioactive Waste (HLW) disposal program, and the underground research laboratory (URL) located about 10 km NE of AECL/Whiteshell.

History of the Canadian HLW Disposal Program

K. Nuttall, Director of Waste Technology at AECL/Whiteshell provided a brief overview of the Canadian HLW disposal program. HLW management in Canada began around 1977 when a special study group recommended research on geologic disposal in Precambrian rocks of the Canadian Shield. In 1978, the Canadian and Ontario governments recommended AECL, a crown corporation receiving partial support from the Canadian Ministry of Natural Resources, conduct research to develop and demonstrate the feasibility of waste immobilization and disposal technology. It is interesting to note that in the Canadian program, both the group responsible for demonstrating feasibility (AECL) and the licensing authority (Atomic Energy Licensing Board or AELB) report to the same government ministry. In 1981, the governments of Ontario and Canada committed to full technical and public review of the disposal concept before any decision would be made on site-specific activities. For this reason, the Canadian program differs from the U.S. HLW program in that although waste disposal is planned for the Canadian Shield, there is no characterization of a specific site. Also, due to the similar design of all Canadian reactors and because there are no nuclear defense activities, Canadian HLW intended for geologic disposal is much more homogeneous than U.S. HLW.

In general, the Canadian disposal concept calls for a repository 500 to 1,000 m in plutonic rocks of the Canadian Shield, stable waste forms, containers with a minimum life of 500 yr, clay-based buffer materials, and backfill. A number of projects to test different aspects of the disposal concept have been conducted at AECL/Whiteshell and at the URL.

In 1994, AECL completed an Environmental Impact Statement (EIS) for the waste disposal concept and submitted it to a review panel of stakeholders and technical experts established by the federal government in 1989. A series of public hearings at over 30 locations were completed in 1997, and both the EIS and a final report were presented to the Minister of the Environment and Minister of Natural Resources in early 1998. Two of the key conclusions by the panel were:

- From a technical perspective, the safety of the AECL concept has been adequately demonstrated for additional development, but from a **social perspective** it has not.

- The AECL concept has **not** been demonstrated to have broad public support. The concept in its current form **does not have the required level of acceptability to be adopted** as Canada's approach for managing nuclear fuel wastes. [emphasis added]

The panel issued a number of recommendations, some technical, but mostly focused on public participation in the HLW disposal process. The federal government issued a response to the Panel recommendations in December 1998 calling for producers and owners of nuclear fuel to establish: (i) a waste management organization of representatives from the producers and owners of nuclear fuel; and (ii) a fund to fully finance all activities and operations of the waste management organization. The waste management organization is to prepare a plan setting out the preferred approach for long-term management of HLW, including evaluation of different options, comparison of risks and cost-benefit analysis of the different options, a comprehensive public participation plan, ethical and social assessment plans, and an Aboriginal participation process.

The Minister of Natural Resources was to return to the Cabinet by December 1999 with a plan to implement these objectives. By the time of this visit (June 2000), the Minister had not yet made this report.

Large Block Radioactive Tracer Tests at AECL/Whiteshell

During late Fall 1999, AECL staff excavated rock from one wall of the Busted Butte facility, leaving a pillar that was removed as three blocks of tuff:

- A smaller test block (~ 0.125 m^3) at the contact between the Topopah Spring tuff and Calico Hills tuff. This block will be used for unsaturated tracer tests.
- A large (~ 1.8 × 1.2 × 1 m) from the upper Calico Hills tuff This block will be used for saturated tracer tests with radioactive tracers.
- A second large test block (~1 m^3) from lower Topopah Spring tuff. This block will be used for radioactive tracer tests under unsaturated conditions.

AECL had to overcome a number of technical challenges in excavating the friable tuff as large blocks and transporting them to AECL/Whiteshell in Manitoba. Plywood forms were used to protect the four sides of each block. Epoxy was poured to fill in the gaps between the form and the rock. A bottom cut was made in the block with a chain saw, and a steel plate inserted. A top cut was then made, another steel plate inserted and the block was removed from the pillar. The three blocks were transported by rental car/truck to AECL/Whiteshell

Once in the laboratory, block surfaces were mapped and the blocks were prepared for the tracer studies. The smaller trial block was used first to demonstrate the laboratory procedures (Attachment 1). The top and bottom surfaces of the block were leveled. An aluminum plate was attached to the bottom of the block, with funnels leading to separate collection vessels. A plexiglass plenum was added to the top, and a drip rate of 20 mL/hr was started using synthetic groundwater prepared to match the chemistry of the Busted Butte UZ pore water. At the time of this visit, a stable flow rate (fluid into block = fluid out of block) had been established, and a tracer cocktail of tritiated water, fluorescein, ^{22}Na, ^{60}Co, $^{95m/99}Tc$, ^{137}Cs, and ^{237}Np was scheduled to be added in a pulse in the following week (early July). During the tracer test, water samples are to be collected using a series of offline horizontal bore holes. There is concern with disturbing the flow regime during sampling, so samples will be infrequent and small.

Final preparation for the larger blocks was still underway and flow had not been initiated in either block at the time of the visit. The block for the saturated tracer test (Calico Hills tuff) had been leveled and the perimeter sealed with a polyethelene sheet (Attachment 2). Vertical inlet, outlet, and sampling ports were to be drilled and the sampling ports instrumented for lateral flow through the block. Sampling will be at five different 10-cm intervals. The block for the unsaturated tracer test zone (Attachment 3) had also been trued and mounted in a test frame. An aluminum plate with a 6 × 6 sampling port array has been attached to the bottom of the block, and a plenum and drip system set at the top to initiate flow, again using synthetic Busted Butte UZ pore water. Because of the large size of the block and the short time available for the experiments, the AECL staff were determining whether to introduce tracers with the initiation of flow instead of waiting for stable flow to be established. Initiation of flow was anticipated for July.

To complement the block tracer tests, AECL was also conducting batch sorption experiments using synthetic J-13 water. Results were not available at the time of the test, but some preliminary results have been reported recently.

Underground Research Laboratory

As part of the Canadian program, and with the aid of the U.S. DOE, AECL has constructed an underground research laboratory (URL) in Precambrian granite, with two levels at ~200 m and ~400 m. The laboratory has been constructed about 10 km NE of the AECL/Whiteshell facility on property leased from the province of Manitoba. The laboratory has been used to conduct tests of different mining techniques, field scale flow and transport experiments, heater tests, and testing of sealing mechanisms. The level of activity at the URL is currently fairly low, and many of the experiments have been completed and/or mothballed. Several field-scale (tens of meters) nonradioactive tracer tests have been conducted using the natural groundwater flow regime, and two hot (radioactive) labs have been constructed for laboratory-scale column and large block tests using radioactive tracers and groundwater collected directly from fractures in the granite. In these experiments, the groundwaters were reducing leading to strong retardation of technetium and neptunium flow. One interesting point is that with the operation and ventilation of the tunnels of the URL, there has been a gradual increase in groundwater uranium concentration due to oxidation. In some cases, this increase has required treatment of pumped water to meet drinking water standards prior to release.

IMPRESSIONS/CONCLUSIONS:

The trip to AECL/Whiteshell had several benefits, both programmatic and technical. From a programmatic viewpoint, the experience of AECL and the Canadian HLW management program during the public comment period will provide valuable insight into the types of issues likely to be raised during the NRC licensing process. The work being done at AECL/Whiteshell for DOE is a one-of-a-kind experiment with using site-specific materials (tuff, groundwater) and radioactive tracers to study radionuclide migration under both unsaturated and saturated conditions. The experiments speak directly to two out of four subissues in the RT KTI: (i) Radionuclide Transport Through Porous Rock; and (ii) Radionuclide Transport Through Fractured Rock. The experiments are also pertinent to two of the model abstractions identified in the YMRP: (i) Radionuclide Transport in the Unsaturated Zone; and (ii) Radionuclide Transport in the Saturated Zone. Several issues raised in the Rev 1 of the RT IRSR regarding the use of larger scale experiments and the appropriateness of nonradioactive tracers as homologues for radionuclide migration are also addressed by the experiments.

As part of preparing to perform this work, AECL/Whiteshell staff committed to and has received training in DOE/Los Alamos National Laboratory QA procedures for areas such as laboratory analysis, instrument calibration, data management, software management, and scientific notebook. This visit was not conducted as part of a QA audit, so no checks of QA implementation and/or effectiveness were performed.

PROBLEMS ENCOUNTERED:

None

PENDING ACTIONS:

The block tracer experiments at AECL/Whiteshell are scheduled to be completed by the end of the current U.S. Government fiscal year. Given the short time frame, it is unlikely that final results on tracer breakthrough will be available. AECL/Whiteshell has proposed follow-up work for a post-mortem analysis of the blocks to locate the tracers and identify mineral associations. The DOE had not approved funding for this work at the time of the visit, but it offers a good opportunity to obtain the maximum information from the tests and offers the best chance of developing and testing conceptual/mathematical models of radionuclide transport.

RECOMMENDATIONS:

NRC/CNWRA staff should continue to monitor results from the AECL/Whiteshell block tracer tests, especially given the programmatic relevance discussed previously under Impressions/Conclusions. If DOE decides to continue funding for the experiments and the post-mortem analysis of the blocks, NRC may want to consider a follow-up trip to speak with AECL/Whiteshell staff about experimental results.

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Date: 08/07/00

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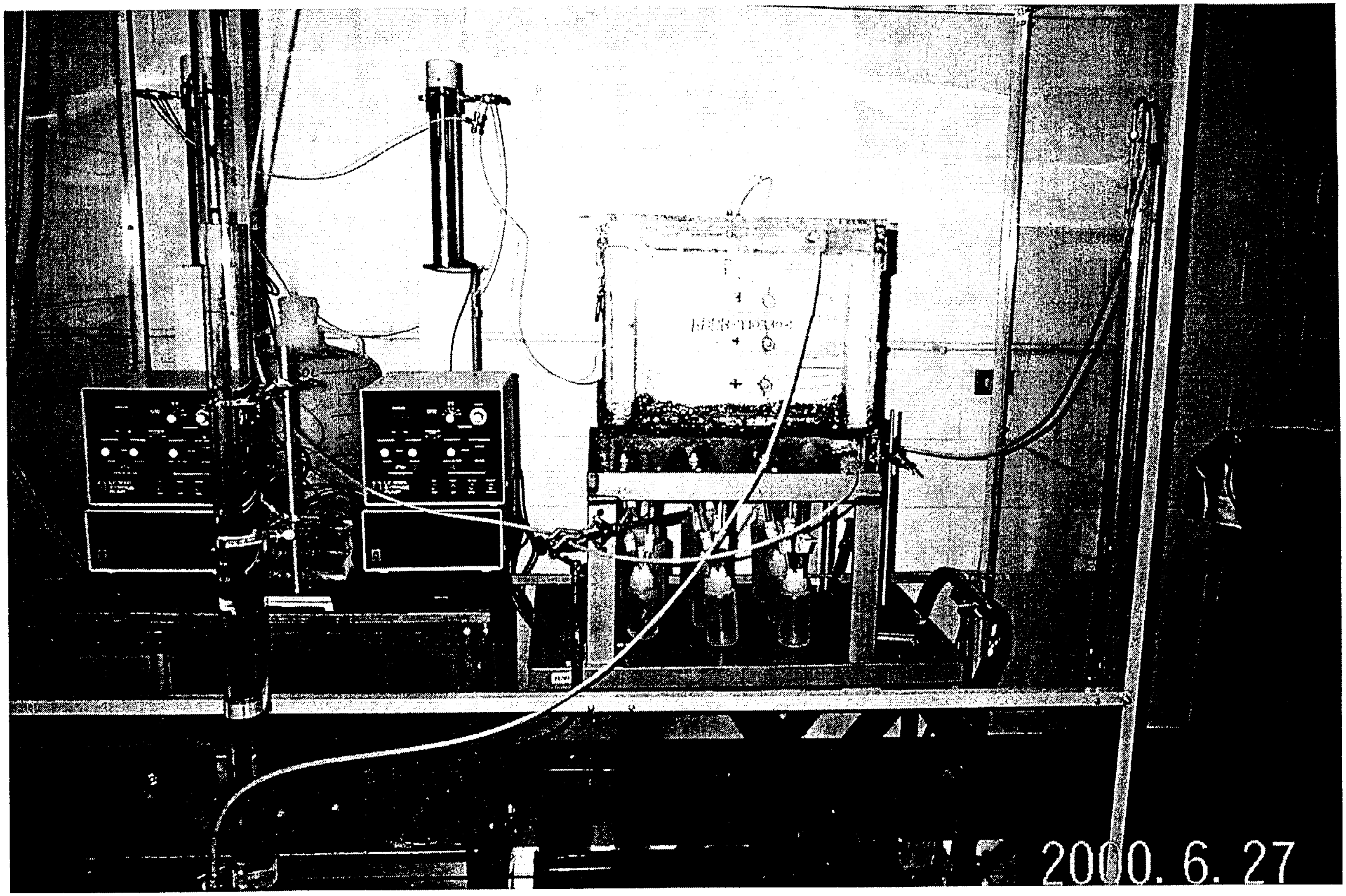
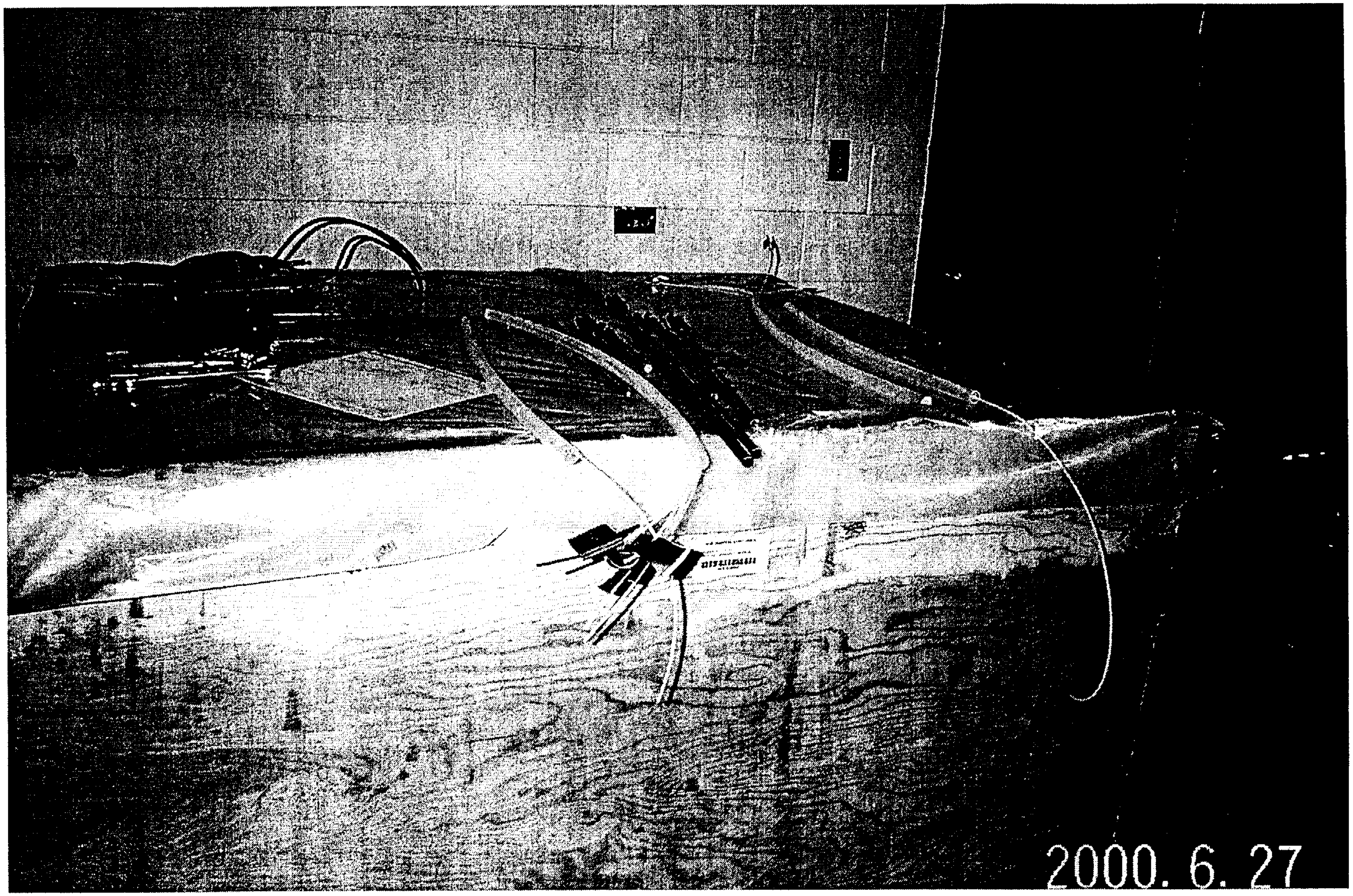
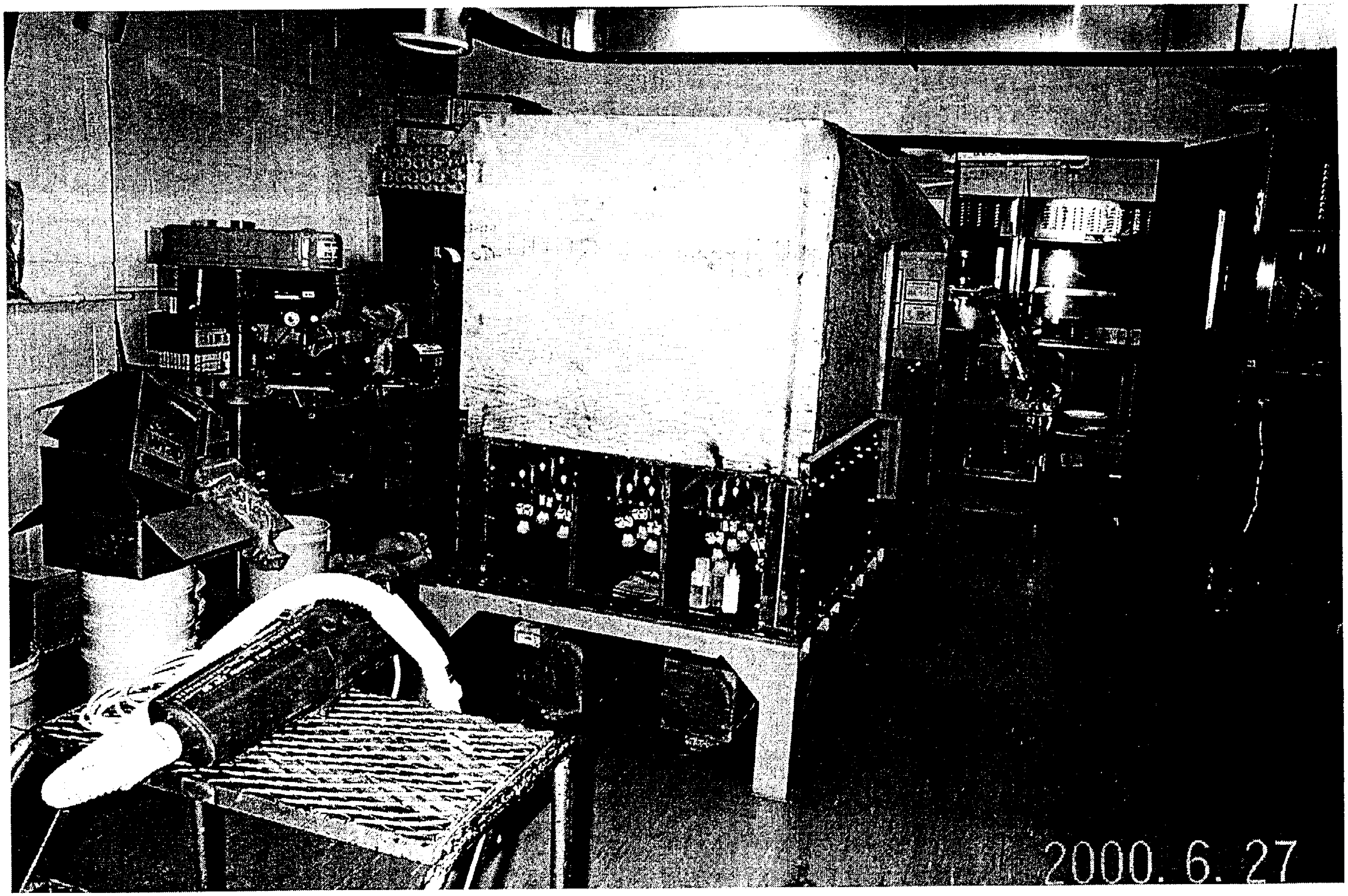


Attachment 1 - Trial Block (~0.125 m^3)



Attachment 2 - Saturated Large Block Test



Attachment 3 - Unsaturated Large Block Test