

RELAP4 APPLICATION TO TMI-2 ACCIDENT

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RELAP4 APPLICATION TO TMI-2 ACCIDENT

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The RELAP4 series of computer programs have been used to analyze the conditions of the Three Mile Island Unit 2 (TMI-2) reactor following the accident of March 28, 1979. Two separate efforts using RELAP4 have been completed. The first effort, which took place during the first two months following the accident, was to use the RELAP4/MOD5 and RELAP4/MOD6 computer programs to study natural circulation cooling. The second effort, which was completed in August 1979, was to calculate the actual transient using RELAP4/MOD7. These efforts are described below.

Natural Circulation Calculations

Questions on the effect of core damage on natural circulation at TMI-2 were raised after the accident and before the system was transferred from a forced circulation to a natural circulation cooling mode. The system after the accident was being cooled using one of the main coolant pumps and one steam generator in a boiling mode. There was concern whether natural circulation could be established when the pump was turned off (or lost) or whether the core flow would stagnate during the transition. A parametric study was made varying the amount of core blockage and steam generator operating conditions. The results of the study indicated sufficient core cooling at all times during the transition. Another concern analyzed was the potential of using high pressure injection and letdown to provide a cold water source and hot water sink should the remaining operating steam generator be lost or degraded in performance. A sensitivity study was made which indicated this alternate method could be used to provide natural circulation core cooling.

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TMI-2 Actual Transient Analysis

An analysis of the actual transient at TMI-2 was performed with a preliminary version of RELAP4/MOD7. The calculation was to assist in a better understanding of the accident and to provide a basis for a parametric study analyzing other scenarios of operator actions. The RELAP4 input model had to be changed to reflect certain phenomena not previously addressed, such as, natural circulation limiting due to steam binding in the hot legs and pressurizer behavior during a loss of coolant from the pressurizer. The calculation showed good agreement with available measured data to the point when the core uncovered and core heatup began.

The primary results from this analysis were as follows:

- (1) A detailed input model was necessary to calculate the phenomena occurring during the TMI-2 accident, resulting in large computer calculational times.
- (2) The calculation indicated much sensitivity to the boundary conditions used, particularly steam generator behavior and the rate of fluid injection.
- (3) The RELAP4/MOD7 computer code does calculate the phenomena actually exhibited by a full-scale pressurized water reactor in this type of off-normal condition.

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RELAP4 Applications to TMI-2

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TMI-2 Support and Analysis

- **Natural circulation calculations**
- **TMI-2 transient analysis**

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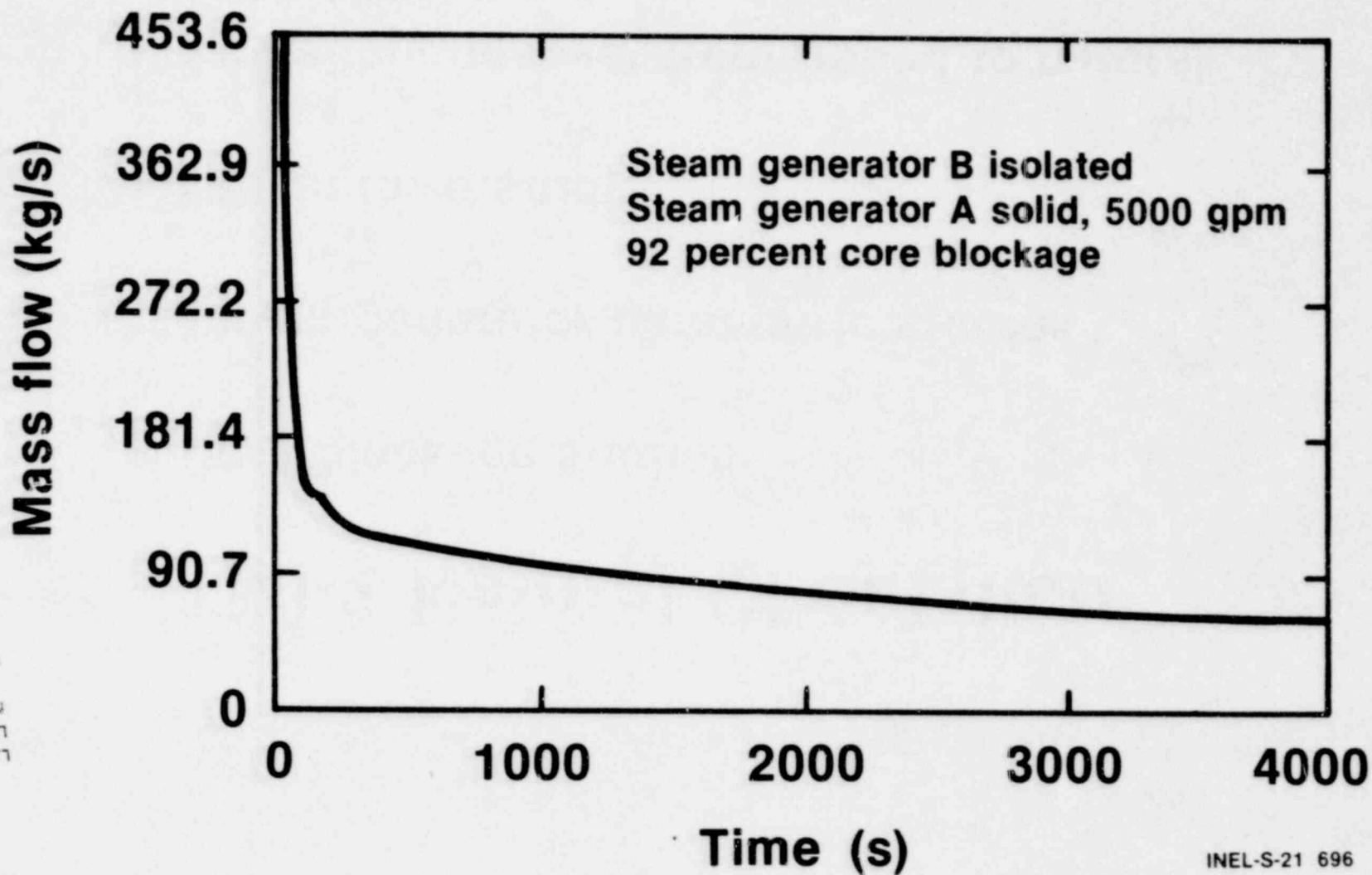
TMI-2 Natural Circulation

- **Core blockage studies**
- **Steam generator parametric studies**
- **HPI-letdown study**
- **Actual changeover from forced to natural circulation**

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TMI-2 Natural Circulation Calculation Core Inlet Flow



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TMI-2 Transient Analysis

- **Obtain understanding of actual transient**
- **Basis for parametric study**
- **Use RELAP4/MOD7 computer program**

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TMI-2 Transient Analysis

- **Familiarization**
 - **Very small break phenomena**
 - **Boundary conditions**
 - **Pressurizer**
 - **Steam generators**
 - **Hot leg**

- **Base case analysis**
 - **47,000 CDC 7600 seconds/6850 transient seconds**
 - **Into core heatup phase**

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TMI-2 Accident Scenario

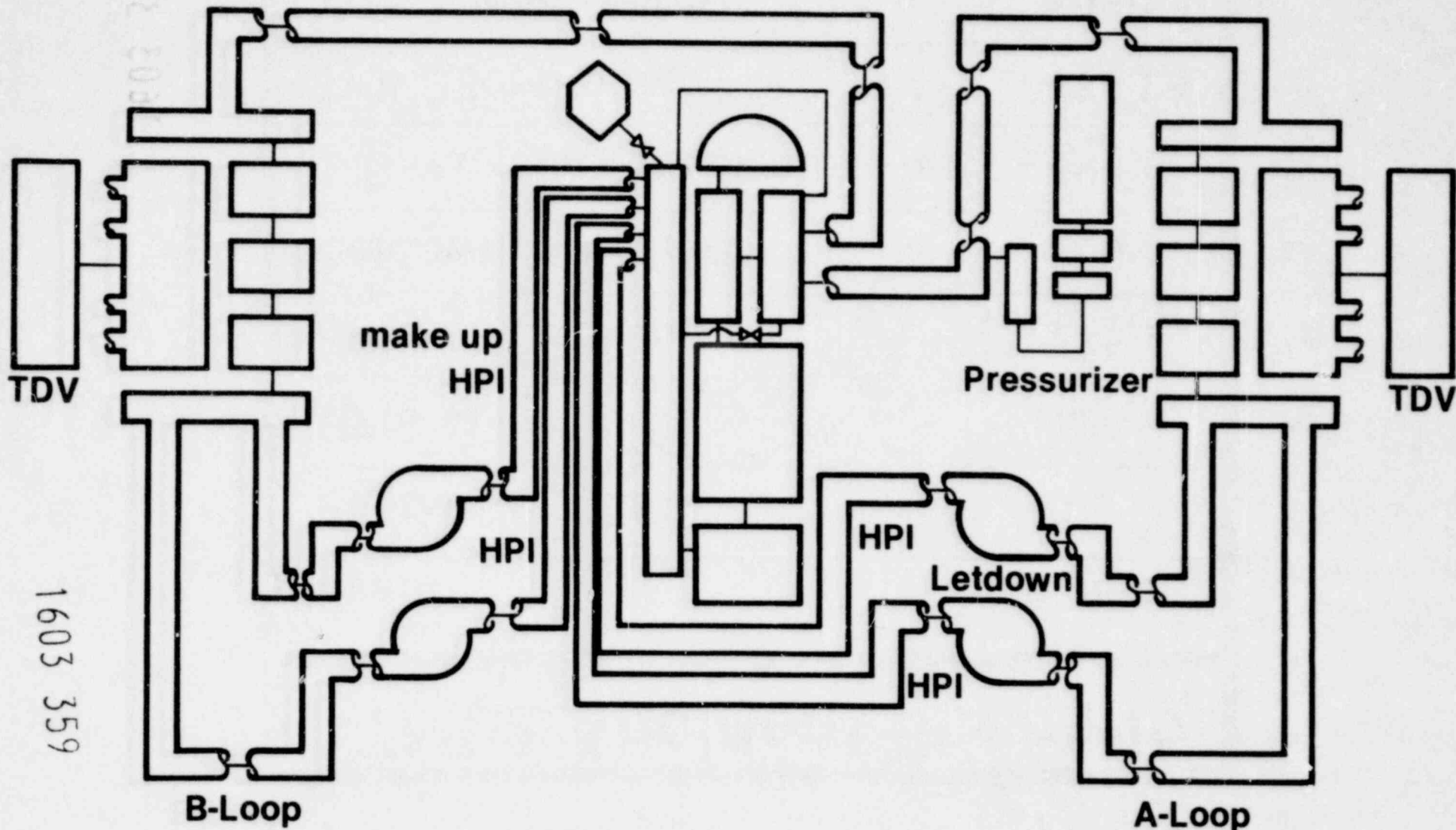
Event	Time
Feedwater trip	0 s
HPIS start	124 s
HPIS off, makeup on	278 s
Letdown flow start	300 s
S.G. auxiliary feedwater start	498 s
Trip B-loop pump	4380 s
Trip A-loop pump	6060 s

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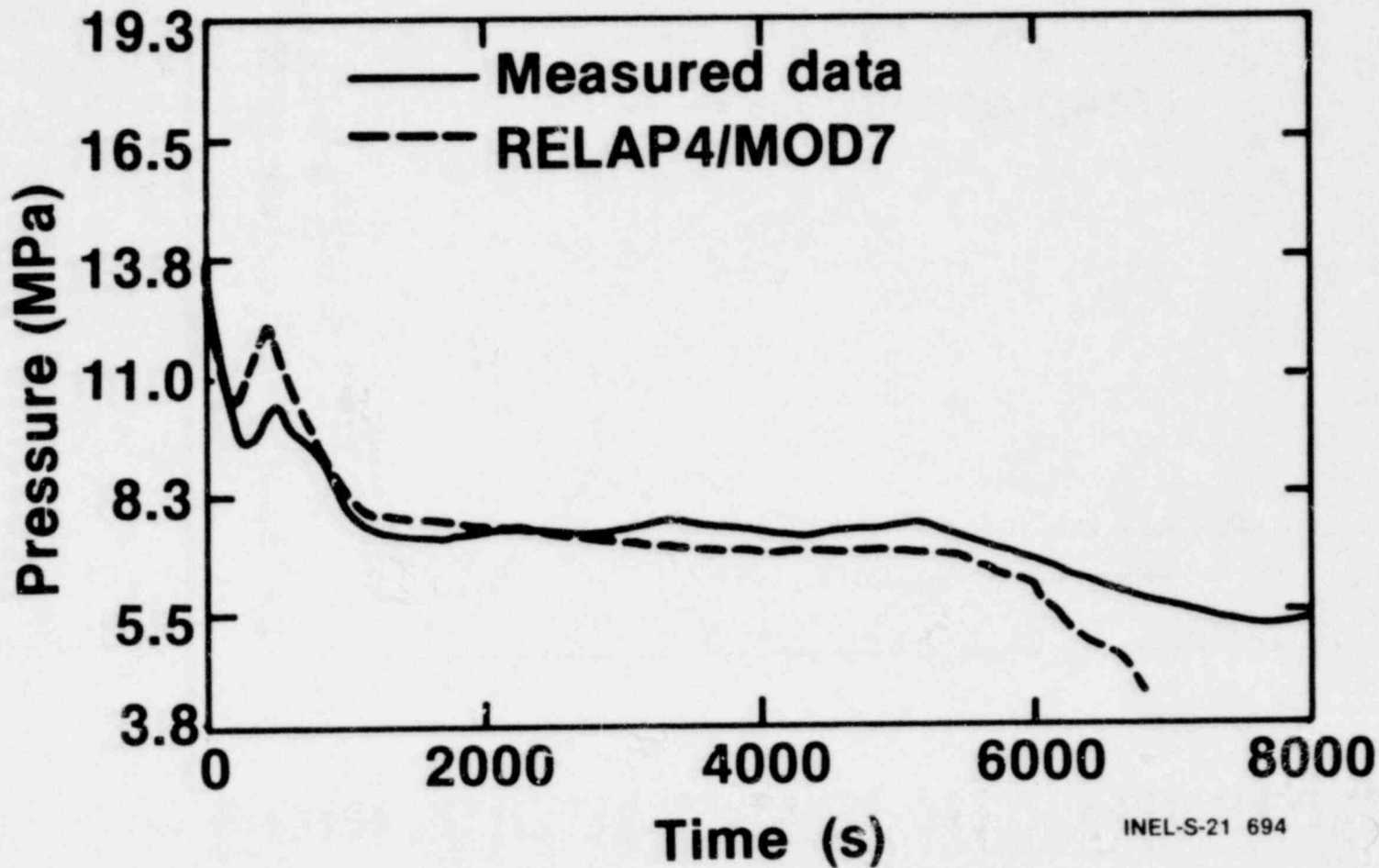
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RELAP4/MOD7 Nodalization Diagram for TMI-2



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TMI-2 Transient Analysis System Pressure

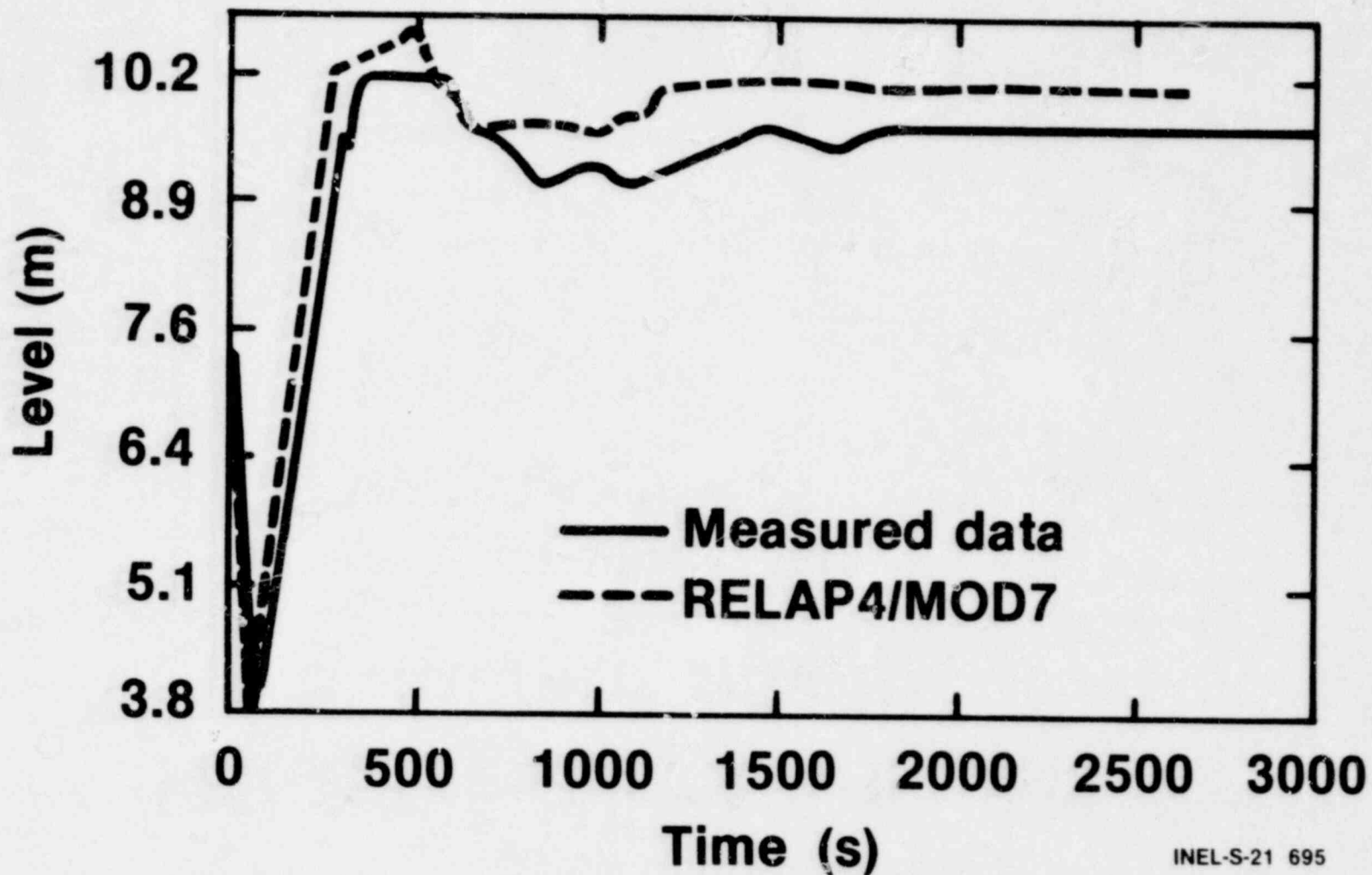


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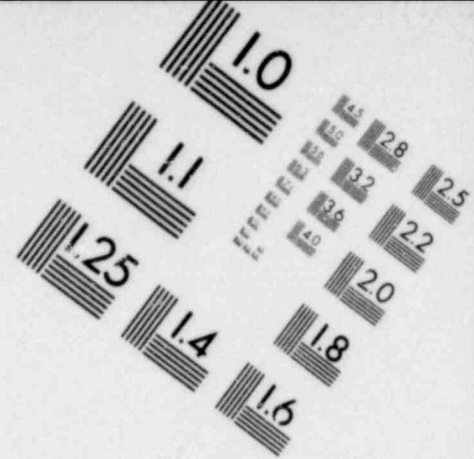
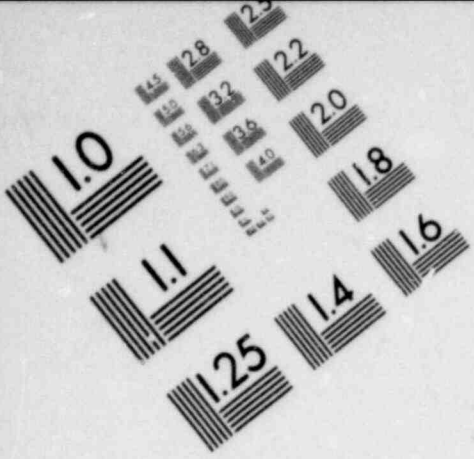
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TMI-2 Transient Analysis Equivalent Level in Pressurizer

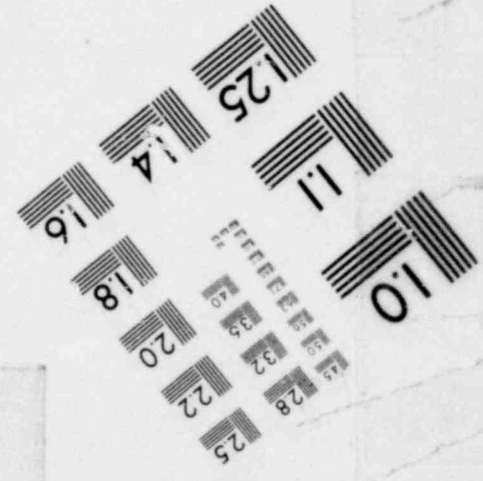
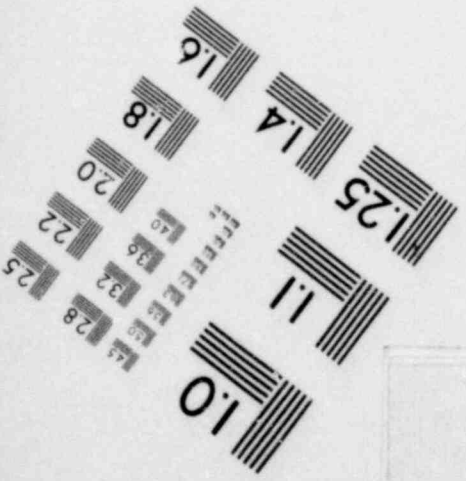
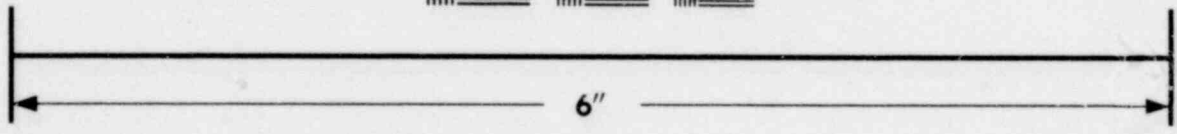
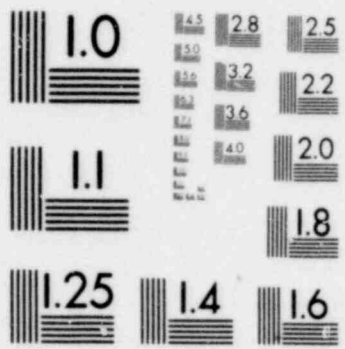


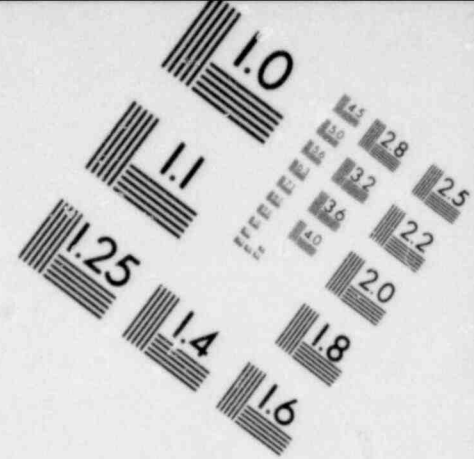
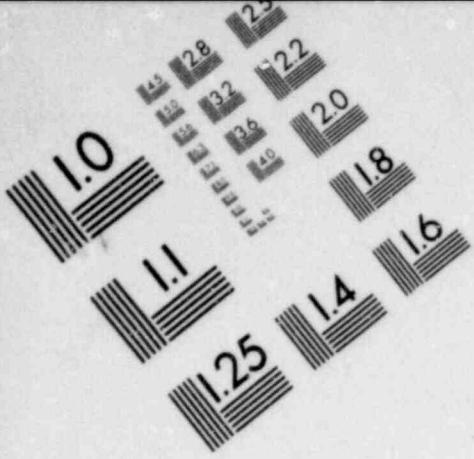
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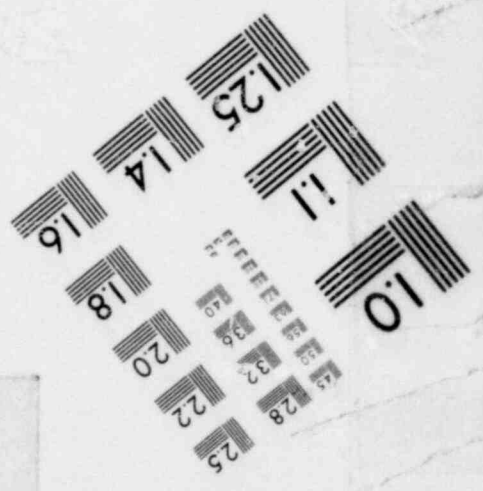
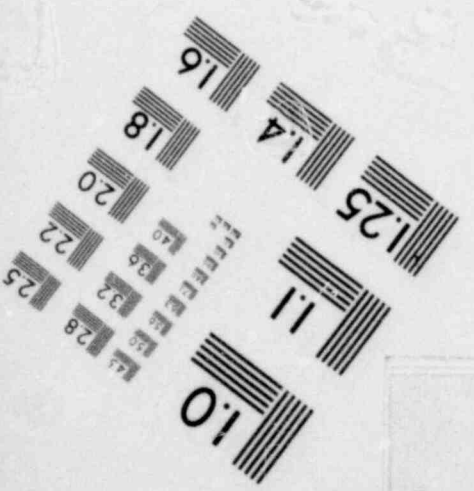
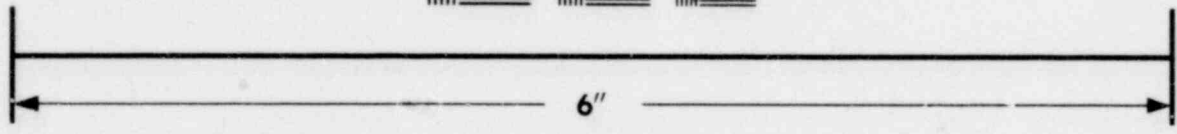
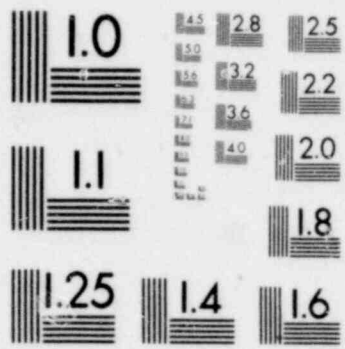


**IMAGE EVALUATION
TEST TARGET (MT-3)**



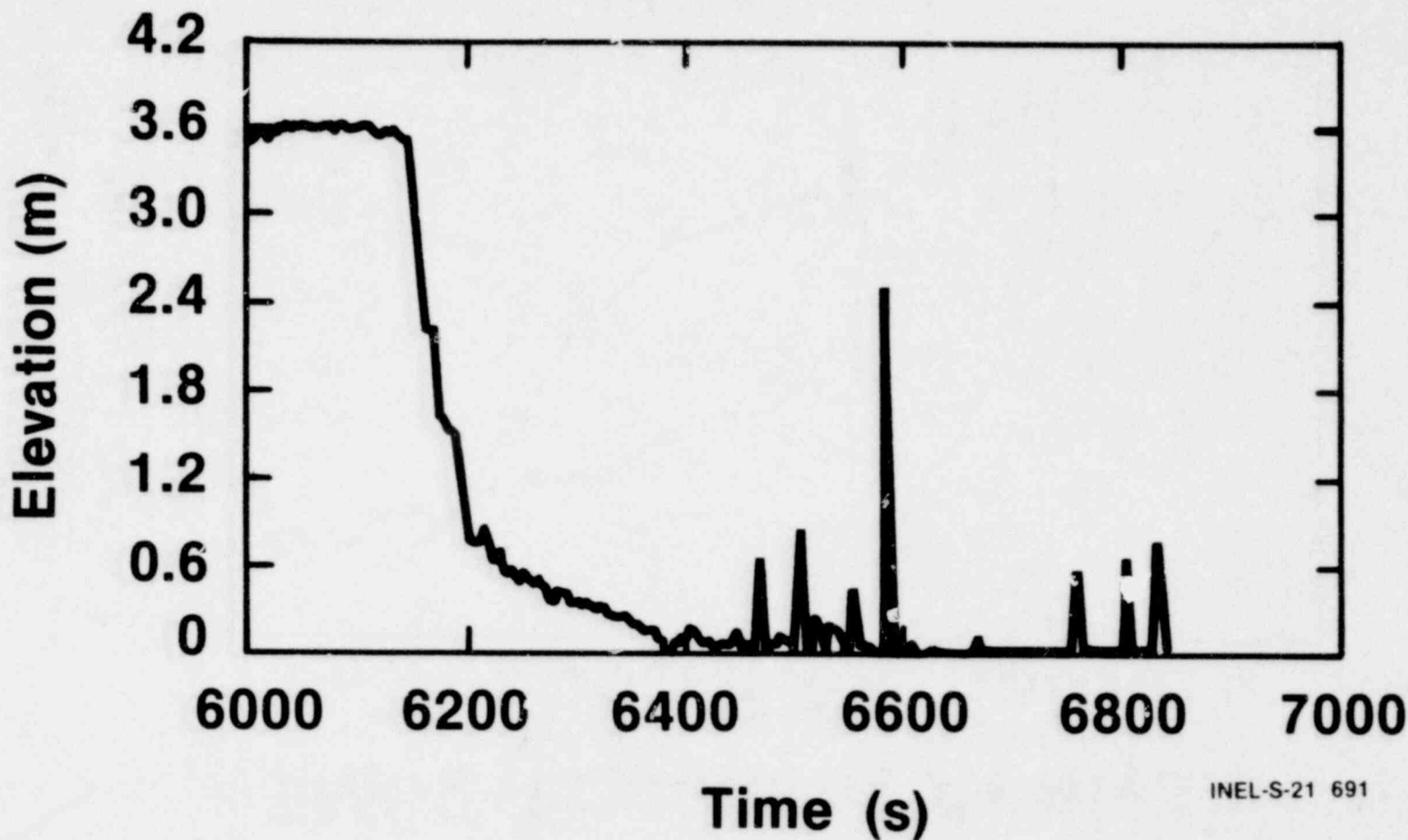


**IMAGE EVALUATION
TEST TARGET (MT-3)**



TMI-2 Transient Analysis

Calculated Core Mixture Level

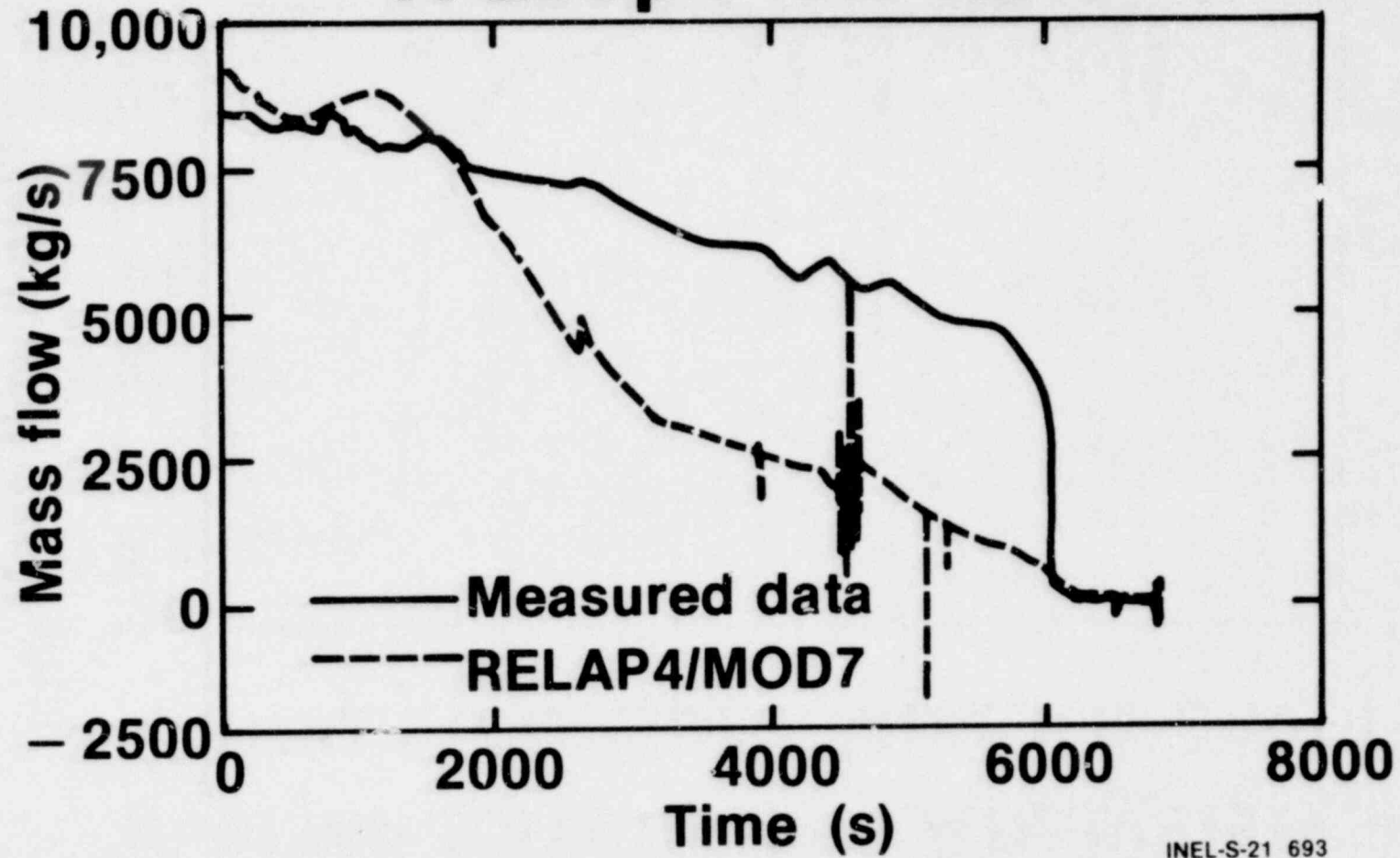


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TMI-2 Transient Analysis A-Loop Flow Rate



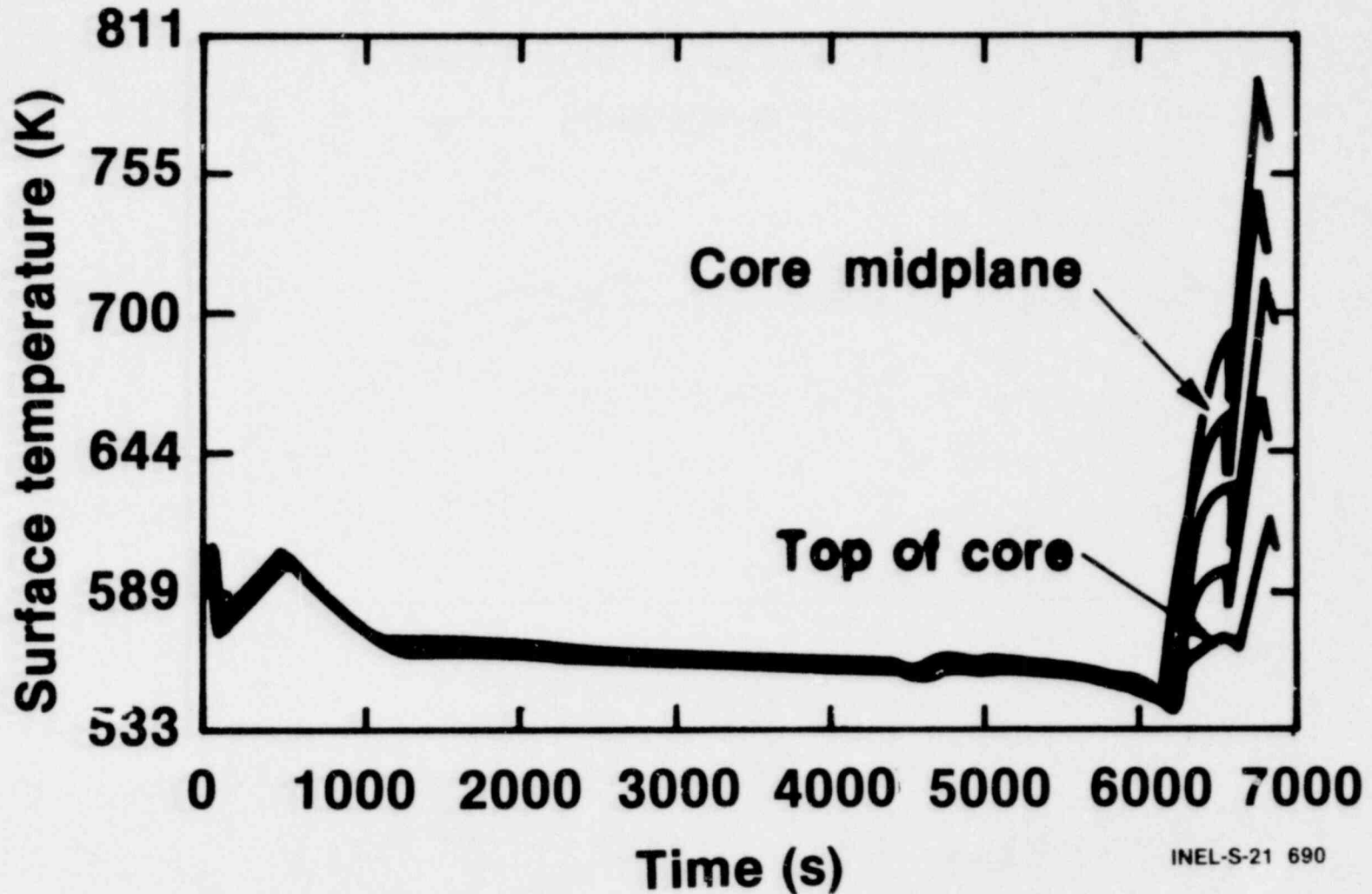
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TMI-2 Transient Analysis

Calculated Core Temperatures

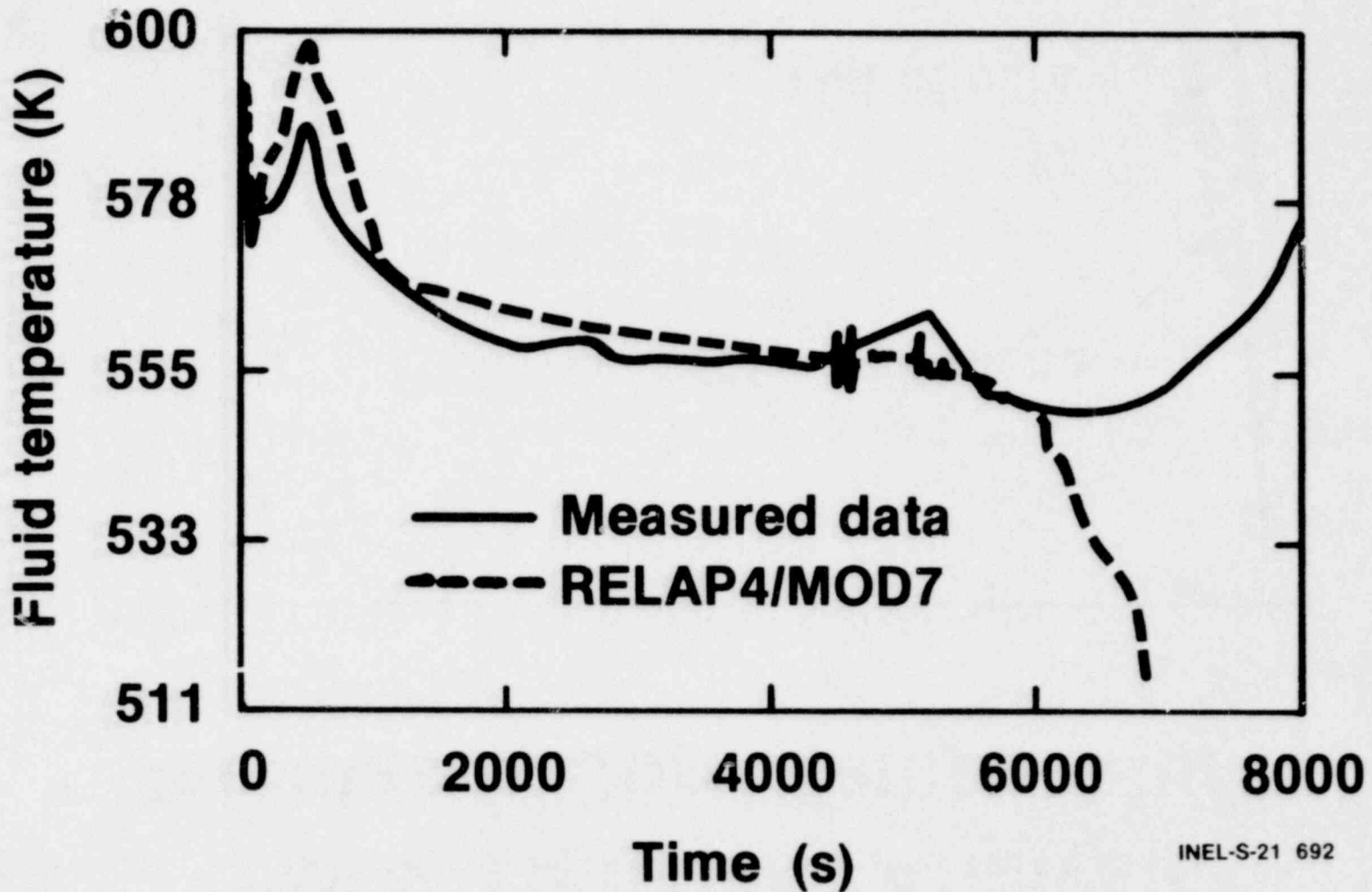


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TMI-2 Transient Analysis B-Loop Hot Leg Temperature



TMI-2 Transient Analysis Conclusions

- **Provides basis for parametric study**
- **RELAP4/MOD7 computer program indicates significant potential for severe core damage given a TMI-2 type scenario**

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