SEVERE ACCIDENT CODE DEVELOPMENT PROGRAM

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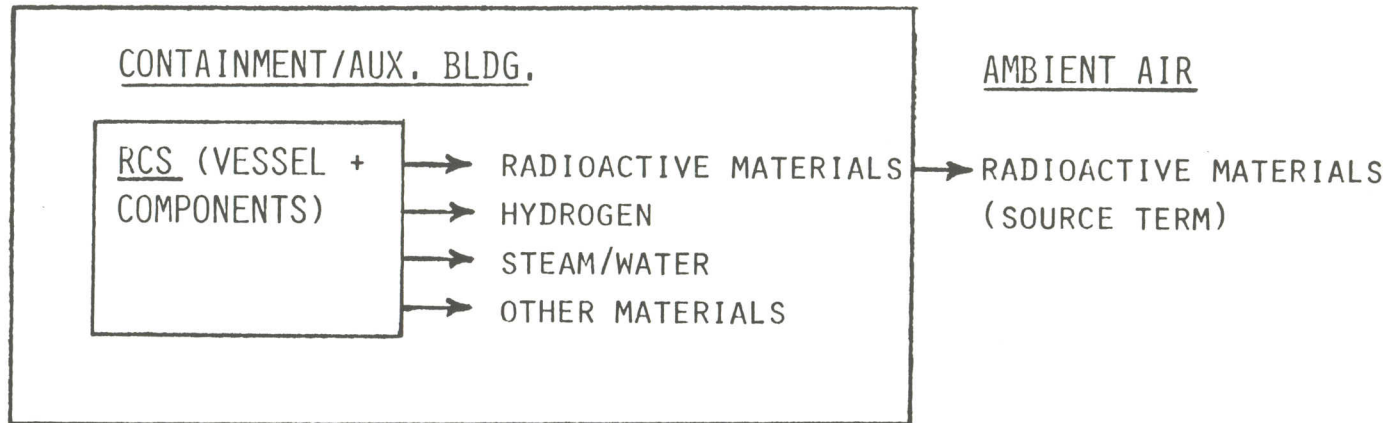U.S. Nuclear Regulatory Commission

ABSTRACT

This paper summarizes the scope and status of the Severe Accident Code Development Program, which is part of the NRC Severe Fuel Damage and Source Term (SFD/ST) Research Program. The Program consists of the development and assessment of the state-of-the-art mechanistic computer codes: SCDAP/RELAP5 and MELPROG/TRAC.

The SCDAP/RELAP5 code has been developed to make detailed analysis of the SFD/ST experiments and also to analyze the progression of the TMI-type "recovered" accidents in the reactor coolant system (RCS) of nuclear power plants. The code is currently operational on a CRAY-I computer and was used successfully to make a pretest prediction for the LOFT FP-2 core damage test with the entire RCS modeled. The MELPROG/TRAC code is being developed to analyze severe accident progression in the RCS up to and including vessel failure. Code assessment and improvement for both codes will continue in the near future.

INTRODUCTION

- THE SEVERE ACCIDENT CODE DEVELOPMENT PROGRAM PRESENTED IN THIS PAPER IS PART OF THE NRC SEVERE FUEL DAMAGE AND SOURCE TERM (SFD/ST) RESEARCH PROGRAM.

- THE PROGRAM CONSISTS OF THE DEVELOPMENT AND ASSESSMENT OF THE STATE-OF-THE-ART MECHANISTIC COMPUTER CODES, SCDAP/RELAP5 AND MELPROG/TRAC, FOR ANALYZING SEVERE ACCIDENT PROGRESSION IN THE REACTOR COOLANT SYSTEM (RCS) OF NUCLEAR POWER PLANTS.

- THE CODES WILL PREDICT THE TIMING AND MAGNITUDE OF THE RELEASE OF FISSION PRODUCTS, HYDROGEN, AND STEAM/WATER TO THE CONTAINMENT AND/OR AUXILIARY BUILDING.

- SEVERE ACCIDENTS IN A NUCLEAR POWER PLANT:

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│                                                          │
│   CONTAINMENT/AUX. BLDG.              AMBIENT AIR         │
│   ┌──────────────────┐                                   │
│   │ RCS (VESSEL +    │──→ RADIOACTIVE MATERIALS──→ RADIOACTIVE MATERIALS
│   │ COMPONENTS)      │──→ HYDROGEN             (SOURCE TERM)
│   │                  │──→ STEAM/WATER                     │
│   │                  │──→ OTHER MATERIALS                 │
│   └──────────────────┘                                   │
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- THE SEVERE ACCIDENT ANALYSIS CODES: SCDAP/RELAP5 AND MELPROG/TRAC

  - ANALYZING SEVERE ACCIDENT PROGRESSION IN THE REACTOR
    COOLANT SYSTEM (RCS)

  - PROVIDING BOUNDARY CONDITIONS TO THOSE CODES MODELING
    CONTAINMENT BEHAVIOR AND INTEGRITY, AND SOURCE TERM

  - SUPPORTING EXPERIMENTAL PROGRAMS - PBF, NRU, ACRR,
    AND CORA

MODULAR STRUCTURE OF SEVERE ACCIDENT ANALYSIS CODES

	RECOVERED ACCIDENT, AND DETAILED MODELING OF SFD/ST EXPERIMENTS	VESSEL-FAILURE SEVERE ACCIDENTS
	SCDAP/RELAP5	MELPROG/TRAC
FUNCTION		
CORE DAMAGE AND MELT (HYDROGEN RELEASE INCLUDED)	SCDAP	MELPROG
THERMAL-HYDRAULICS	RELAP5	TRAC, MELPROG
FISSION PRODUCT RELEASE AND TRANSPORT	PARAGRASS/ TRAP-MELT	VICTORIA
VESSEL FAILURE	-	MELPROG
MATERIAL PROPERTIES	MATPRO	MATPRO

SEVERE ACCIDENT PROGRESSION IN THE RCS OF A NUCLEAR PLANT

	RECOVERED ACCIDENTS, AND DETAILED MODELING OF SFD/ST EXPTS.	VESSEL-FAILURE SEVERE ACCIDENTS
	SCDAP/RELAP5	MELPROG/TRAC
NORMAL OPERATION	RELAP5	TRAC-PF1
ACCIDENT/TRANSIENT	RELAP5	TRAC-PF1
CORE UNCOVERY	RELAP5	TRAC-PF1
CORE DAMAGE AND MELT	SCDAP/RELAP5	MELPROG/TRAC
STEAM GENERATION BY CORE DEBRIS IN LOWER PLENUM	SCDAP/RELAP5	MELPROG/TRAC
VESSEL FAILURE	—	MELPROG/TRAC

SCOPE OF SEVERE ACCIDENT CODE DEVELOPMENT PROGRAM

- DEVELOP SCDAP AND MELPROG

- DEVELOP STAND-ALONE CODES - PARAGRASS, TRAP-MELT, VICTORIA, AND MATPRO

- MODIFY EXISTING THERMAL-HYDRAULIC CODES - RELAP5, TRAC

- INTEGRATE THESE CODES TO PROVIDE SYSTEM-WIDE SEVERE ACCIDENT ANALYSIS

- ASSESS THE CODES BY COMPARING CALCULATIONS WITH EXPERIMENTAL AND ANALYTICAL RESULTS

CODE STATUS

- THE SCDAP/RELAP5 CODE (INCLUDING TRAP-MELT) IS OPERATIONAL ON A CRAY-I COMPUTER. IT WAS USED SUCCESSFULLY TO MAKE A PRETEST PREDICTION FOR THE LOFT FP-2 CORE DAMAGE TEST WITH THE ENTIRE RCS MODELED.

- STAND-ALONE SCDAP CODE HAS BEEN AND WILL CONTINUE TO BE USED TO ANALYZE SFD/ST EXPERIMENTS.

- A PRELIMINARY VERSION OF MELPROG HAS BEEN RELEASED: 1-D THERMAL HYDRAULICS, AND VICTORIA NOT INCLUDED.

- MELPROG NOW HAS 2-D THERMAL HYDRAULICS FOR THE VESSEL. IT WILL INCLUDE VICTORIA AND WILL BE COUPLED WITH TRAC TO MODEL THE ENTIRE RCS.

- CODE ASSESSMENT, IMPROVEMENT, AND DEBUGGING WILL CONTINUE.

SUPPORT AND INTERACTION WITH OTHER PROGRAMS