



ACRES INTERNATIONAL LIMITED  
4TH FLOOR, BEOTHUCK BUILDING, CROSBIE PLACE  
P.O. BOX 13337, STATION A  
ST. JOHN'S, NEWFOUNDLAND  
A1B 4B7

HYDROTECHNICAL STUDY  
STEPHENVILLE CROSSING AND BLACK DUCK SIDING AREAS  
ACRES RIVER ICE SIMULATION MODEL (ICESIM)

PROGRAM DOCUMENTATION

FOR

CANADA NEWFOUNDLAND FLOOD DAMAGE REDUCTION PROGRAM

JULY 1988

## TABLE OF CONTENTS

	<u>Page</u>
1 - INTRODUCTION . . . . .	1
2 - MODEL SETUP FOR HARRY'S RIVER ICE ANALYSIS . . . . .	2
3 - INPUT INSTRUCTIONS . . . . .	4
3.1 - Input Data Required . . . . .	4
3.2 - Input Variable Definitions for 'Filename1.DAT' . . .	5
4 - HOW TO RUN THE PROGRAM . . . . .	10

## 1 - INTRODUCTION

ICESIM is a river ice simulation model originally conceived as a tool in analyzing the numerous ice problems in the construction of the Limestone generating station on the Nelson River in Manitoba. It has since been used by Acres for over 15 years on a number of projects for a variety of purposes from ice management studies to flood plain studies. The model has been applied successfully to many Canadian rivers which vary dramatically in size, climate, and geography.

ICESIM is a time-step backwater model which simulates the major ice processes in a fragmented river ice cover during the formation/freeze-up period or the break-up period. The model is based on a number of empirical and physically based formulae which have been developed independently by various investigators to characterize difference ice processes.

A more detailed description of the ICESIM model is provided in Chapter 8 of the main report of the Hydrotechnical Study of the Stephenville Crossing and Black Duck Siding Area. The model has been released to the Department of Environment and Lands for further ice analyses on Harry's River. The following sections present information on the model setup, how to run the program as well as a description of the input data files used for the Harry's River ice study.

## 2 - MODEL SETUP FOR HARRY'S RIVER ICE ANALYSIS

ICESIM requires input of a data file containing ice analysis data and users options as well as the HEC-2 section data files.

For the Harry's River Ice Analysis, the model has been set up independently for the freeze-up and break up cases. Separate HEC-2 data files were prepared to account for the different ice processes observed on Harry's River. For the freeze-up analysis, flood plain areas containing ice in storage with little or no conveyance were removed so that the ice would only progress in the river reaches and not in the overbank areas. For the break-up case, the flood plain areas from Hobb's farm to Tanglewood Ranch are included since ice has been observed to flow over these areas. Two versions of the HEC-2 data files are provided for pre-excavation and post excavation cases. The HEC-2 file names are

ICEFRZC.DAT - Freeze-up pre excavation (calibration)  
ICEFRZ.DAT - Freeze-up post excavation  
ICEBRKC.DAT - Break-up pre excavation (calibration)  
ICEBRK.DAT - Break-up post excavation.

The input data files are also set up independently for each type of event. For the ice formation analysis, the input ice files are

FRZ85C.DAT - Ice data freeze-up pre excavation (calibration)  
FRZ85.DAT - Ice data freeze-up post excavation.

For the break up case, separate input ice data files were prepared for each jam location. (Section 2 + 063, 2 + 702 and 4 + 677). These files are

BRK84C1.DAT

BRK84C2.DAT

BRK84C3.DAT

BRK841.DAT

BRK842.DAT

BRK843.DAT.

### 3 - INPUT INSTRUCTIONS

#### 3.1 - Input Data Required

Three types of data files are required:

- (a) 'filename1'.DAT - This file is used to input ice mechanic data and specify users options. A description of the variables included in this file is given in Section 2.1.
- (b) 'filename2'.DAT - This file contains elevation, area, conveyance, top width, critical discharge and ice conveyance data for each cross section. Distances between cross sections are also given. This file is generated during execution of the program when the HEC-2 file is read.
- (c) 'filename3.DAT - This file contains input information in HEC-2 data format. The program searches the HEC-2 file and extracts information from the NC, X1 and GR cards.

Note that once the HEC-2 data has been read for a specific case (i.e. freeze-up or break-up) and saved under filename2.dat, it is not necessary to re-read the HEC-2 file again unless changes are made to the HEC-2 cross section data.

### 3.2 - Input Variable Definitions for 'Filename1.DAT'

<u>Card No.</u>	<u>Variable Name</u>	<u>Description</u>	<u>Variable Type</u>
1	TITLE	Title of job	Char
2	NSEC	Number of cross sections in run	I
	Q	Discharge (m <sup>3</sup> /s)	R
	WSELEV(1)	Starting water surface elevation at downstream end (m)	R
	CHAIN1	Actual chainage at downstream section (km)	R
3	IPRINT	Output trigger whenever number of sections ice cover advance $\geq$ IPRINT	I
	DPRINT	Output trigger whenever distance ice cover advances $\geq$ DPRINT (m)	R
	TPRINT	Output trigger whenever change in time between output $\geq$ TPRINT (day)	R
	IDEB	Debug code (0=off, 1 or 2)	
	DEPT1	Time 1 for debug	
	DEPT2	Time 2 for debug	
	IDEBS1	Section 1	
	IDEBS2	Section 2	
4	DAYST	Starting day	R
	DAYEND	Ending day	R
5	VMAX	Maximum allowable velocity at which ice is deposited under an ice cover (m/s)	R
	VERODE	Erosion velocity (m/s)	



<u>Card No.</u>	<u>Variable Name</u>	<u>Description</u>	<u>Variable Type</u>
(continued)			
5	SMX	Maximum slope (warning if BKW gradient is > SMX)	R
	VGRAD	Maximum volume of ice deposited in one call to DPOSIT subroutine ( $m^3$ )	R
6	AOWUS	Open water area upstream of upstream boundary section ( $m^2$ )	R
	NZERO	Section number having open water downstream	I
	AZERO	Open water area downstream of Section NZERO ( $m^2$ )	R
7	COHSN	Cohesion of fragmented ice riverbank (Pa)	R
	COHSNTH	Cohesion of thermal ice to riverbank (Pa)	R
	COHSNPK	Cohesion of packed ice to riverbank (Pa)	R
8	NSTH	Thermal ice section number	I
	TLAKE	Thermal ice thickness (m)	R
	ENLAKE	Manning's 'n' roughness of thermal ice	R
	RAISE	Nominal increase in downstream water level when ice is passed beyond boundary (m)	R
9	NPKSTRT	Section number at downstream extent of packing	I
	NPKSTP	Section number at upstream extent of packing	I
	ENPACK	Manning's 'n' roughness of pack ice	R

<u>Card No.</u>	<u>Variable Name</u>	<u>Description</u>	<u>Variable Type</u>
(continued)			
10	NREAL	Code which determines rough- ness values  0 - dummy n = 1.0 values used to process data  1 - actual n values used to process data	I
	IWINTER	Code which indicates daily time series  0 - daily air temperatures 1 - daily volume of ice 2 - both	I
	NSECBKW	Number of sections which frame backwater profile from ice cover	I
	NCALOW	Open water or ice run (0-open water, 1-ice)	I
	ACCUR	Tolerance of backwater convergence (m)	R
11	FRCRIT	Critical Froude number	R
	KBANK	$K_1 \tan \phi$	R
	KICE	Coefficient analogous to Rankine's passive soil coefficient, $K_2$	R
	FUNIT	Wind drag force (Pa)	R
	DICE	Average content of ice in ice cover ( $\text{kg/m}^3$ )	R
11A	NQ	Number of sections with variable flow	I

<u>Card</u> <u>No.</u>	<u>Variable</u> <u>Name</u>	<u>Description</u>	<u>Variable</u> <u>Type</u>
---------------------------	--------------------------------	--------------------	--------------------------------

(continued)

NOTE: Repeat card 11B NQ times.

11B	NQQ	Section number	I
	QNEW	New flow	R
12	NSILT	Number of sections having a shift in cross section nature	I

NOTE: Date for card 13 required only if NSILT > 0.  
Repeat card 13 NSILT times.

13	NSIL	Cross section number	I
	SIL	Datum shift amount	R
14	MCOEF	Coefficient in border ice equation [0.0 if fraction of water open = f (degree- days)]	R

NOTE: Data for cards 15 and 16 required only if  
MCOEF = 0.0

15	NPBI	Number of points in degree- days/fraction of open water area relationship	I
16	DD	Degree-days	R
	PBIA	Fraction of open water area	R

NOTE: Card 16 is repeated NPBI times.

17	NUMSW	Number of section with varying (open water) or ice roughnesses	I
	VNCHAN(1)	Channel Manning's 'n' roughnesses at downstream section	R
	VNICE(1)	Manning's 'n' ice rough- nesses at downstream section	R

<u>Card No.</u>	<u>Variable Name</u>	<u>Description</u>	<u>Variable Type</u>
-----------------	----------------------	--------------------	----------------------

(continued)

NOTE: Data for card 18 required only if NUMSW >0.  
Card 18 is repeated NUMSW times.

18	NSWITCH	Cross section number	I
	VNCHAN	Channel Manning's 'n' roughness at section NSWITCH	R
	VNICE	Ice Manning's 'n' roughness at section NSWITCH	R

19	NOBSTER	Number of obstructions	
----	---------	------------------------	--

NOTE: Data for card 20 required only if NOBSTR >0.  
Card 20 is repeated NOBSTR times.

20	NA	Cross section number	I
	DISTADD	Additional shoreline distance (due to island etc) (m)	R
	BFACTOR	Reduction in ice forces to account for grounding of ice etc.	R

NOTE: Data for cards 21 and 22 required only if  
NCALOW = 1.

NOTE: Data for card 21 is required only if IWINTER = 0 or 2. Card 21 is repeated from day DAYST to day DAYEND.

21	TEMP	Daily air temperature (°C)	R
----	------	----------------------------	---

NOTE: Data for card 22 is required only if  
IWINTER = 1 or 2. Card 22 is repeated from day DAYST to day DAYEND.

22	VOLADD	Daily ice inflow volume to study area (m <sup>3</sup> )	R
----	--------	---	---

#### 4 - HOW TO RUN THE PROGRAM

The program is written in Fortran and has been set up to run interactively with the user responding to the program prompts.

To run the program, type

@ICESIM

The user is prompted for the following information.

- (a) Input the name of the ice data file  
(filename1.DAT)
- (b) A choice is given to use processed data

For response:

Yes - Input the name of the file to read processed hydraulic from  
(filename2.DAT)

No - Input the name of the file to read HEC-2 data from  
( 'filename3'.DAT ).

- Input the name of the file to save processed hydraulic to  
( 'filename2'.DAT ).

- (c) A choice is given to use dummy 'n' values.

For response:

Yes - Ice and bed roughness are set equal to 1. (NREAL = 0 in  
filename1.dat)

No - Input the under ice cover roughness value. (NREAL = 1 in  
filename1.dat).

For the Harry's River analysis, the HEC-2 data was processed using dummy 'n' values and the 'n' values for the riverbed and ice were specified in 'filenamel.dat' (card 17).

