CA9700832

REFUEL
AUTOMATED REFUELLING PROGRAM FOR CANDU REACTORS

ALAN GRAY

AECL, Reactor Core Physics Branch
2285 Speakman Drive, Mississauga, Ontario, CANADA L5K1B2

ABSTRACT

REFUEL is a Fortran-77 code that has been successfully used to perform extensive refuelling simulations for 480-channel and 380-channel CANDU reactors using natural and enriched fuel. The REFUEL program is run in series with the RFSP program (Reactor Fuelling Simulation Program which performs core simulations – Ref. 1), to choose the channels to be refuelled for the next full-power-day (FPD), and carry out a one FPD simulation. The program is automated, using a batch file, to produce an RFSP input file to simulate refuelling of the next FPD, and to execute RFSP with that input to produce an output file that is ready for use in the next refuelling step. The code can easily be adapted to choose the optimum channels to be refuelled for any CANDU reactor.

1. INTRODUCTION

The REFUEL program is designed to read the output of an RFSP simulation and to recommend the appropriate fuel channels to be refuelled over the next full power day (FPD). It performs this task in several distinct steps, which have been made into modular components of this program. The flowchart of these modules is shown in Figure 1.

First, an application of up to 20 rules is used to eliminate approximately 90% of the channels from further consideration. The rules are adjusted automatically in order to provide the required number of candidate channels for further consideration. Second, the potential candidate channels are ordered, based on zone fill levels, the number of channel candidates in each zone, front-to-back tilt, and by the K-increase, i.e. estimated reactivity increase upon refuelling.

Third, the channels are selected for refuelling, starting with the channel with the highest K-increase at the high end of the front-to-back tilt. The zones to be refuelled first are the pair of zones with the lowest average fill and the fewest candidates. Special care is taken to avoid refuelling channels too close together. If the number of channels identified for refuelling is higher or lower than that required for a given FPD, the program will automatically adjust the refuelling requirements by adjusting the target zone fills for the following FPD to require an increase or decrease in expected reactivity. The channel selection will then be repeated.

Finally, the program uses this information to build an RFSP input file to simulate the next day of the refuelling process. The template for this input file is reactor specific, and must be developed for each type of reactor, if not already available. It contains power limits, the refuelling step-size, and a set of 20 rules with rule limits that can be adjusted by the user. Each rule is identified by an integer, which is added to an array, that is used to determine the rules that failed for any channel.

This program was originally written for refuelling simulations of a 480 channel CANDU reactor. However, REFUEL has been modified to simulate refuellings for 380 channel and 640 channel CANDU core designs also.

2. AUTO-REFUELLING METHODOLOGY

There are three stages to the automatic selection of channels for refuelling. These are the elimination stage, ordering of the remaining candidates, and the final selection stage. Twenty rules are used to arrive at the final set from which the channels to be refuelled will be chosen. The process is iterative and the refuelling rates are automatically adjusted during each iteration in order to arrive at the final optimum set of channels to be refuelled. Once the channels to be refuelled have been chosen, the program creates a new RFSP input file with this data, to simulate refuelling of the next FPD.

2.1 ELIMINATION RULES

The first stage in the selection of channels for refuelling is to create a set of reactor fuel channels for refuelling considerations. The elimination of over 90 % of the channels from further consideration is accomplished through the application of the first 17 rules, each of which must be met by every candidate channel, to maintain eligibility for refuelling. Each of these rules can be turned on or off by setting a logical array variable in the input file to T or F respectively.

Rules 1 to 13 are limits on the maximum bundle and channel power of each channel and its neighbours. Rules 14 to 16 are minimum limits on burnup and time between successive refuellings. These limits are shown as the values of the array RLIMIT in Table 1. The actual rule limits are read from the input file. The order of these rules can not be adjusted in the input file, but the value of the rule limits and whether or not they are used is adjustable.

If a channel is eliminated by any of these rules, the i,j entry of a marker array called IRULE is incremented by some number which can be used as a trace to identify later which rules the channel failed to pass. This array is very important in the initial creation of rule limits for a different core design. If IRULE(i,j) remains zero after the application of rules 1 through 17, the channel becomes a candidate for further selection criteria. Otherwise the number is the sum of increments added for all the reasons listed below that the channel should not be refuelled.

As a first guess, each rule should eliminate at least 60% of the channels on the first pass, because a high-powered channel will generally fail many of the following rules. The ideal initial rule base will allow about 10% of the total required channels to qualify as refuelling candidates on the first pass, because the channels are later put into the order in which they originally qualified.

The first set of 13 elimination rules are maximum values of the given property that can be accepted for a channel to be refuelled :

Rule # 1 Maximum Channel Power of Channel Being Refuelled (kW)

Rule # 2 Maximum Rippled Channel Power of Channel Being Refuelled (kW)

Rule # 3 Maximum Bundle Power of Channel Being Refuelled (kW)

Rule # 4 Rippled Maximum Bundle Power of Channel Being Refuelled (kW)

Rule # 5 Maximum Ripple over Time-Average of Channel Being Refuelled (Percentage x 10 of Time-Average)

Rules 2 and 4 rely on a rough estimation of the refuelling ripple in kW as a function of the K-increase in µk. Channels that have a large ripple on refuelling will also have a large K-increase in the *PRTPWR output. For example, the Rule # 2 limit is compared to : channel power multiplied by (1 + the K-increase on refuelling divided by 2000).
The next eight rules can be referred to as the neighbouring channel rules. These neighbouring channels are represented in Figure 2.

Rule # 6 Maximum Channel Power of 4 First-Neighbours (kW)

Rule # 7 Maximum Channel Power of 4 Second-Neighbours (kW)

Rule # 8 Maximum Channel Power of 12 Third-Neighbours (kW)

Rule # 9 Maximum Channel Power of 16 Fourth-Neighbours (kW)

Rule # 10 Maximum Bundle Power of 4 First-Neighbours (kW)

Rule # 11 Maximum Bundle Power of 4 Second-Neighbours (kW)

Rule # 12 Maximum Bundle Power of 12 Third-Neighbours (kW)

Rule # 13 Maximum Bundle Power of 16 Fourth-Neighbours (kW)

The next two rules are for the minimum time between successive refuellings, or refuelling of neighbouring channels. These neighbouring channels are represented in Figure 3.

Rule # 14 Minimum Time Period between successive Refuellings (FPD)

Rule # 15 Minimum Time Period between Refuelling of the 8 Immediate Neighbours (FPD)

Rule # 16 Minimum Burnup as a Fraction of Time-Average Fuel Burnup Rule (Percentage of Time-Average)

Rule # 17 Previously Selected Channel Rule (Tested Power too High)

This option applies if the refuelling calculation is repeated for a particular FPD. Channels that exceed the maximum channel power and bundle power limits are recorded in a file called "failures.in". The number of channels that fail this criterion are stored in the "refuel.inp" file as NELIM, and this number is read in at the beginning of execution. If this number is greater than zero and RULE(17) is .TRUE., then the program will read in the first NELIM entries in "failures.in". Previously selected channels, which exceeded power limits in an RFSP simulation or caused neighbouring channels to exceed power limits, will be ineligible as potential candidates in a repeated case.

Rule # 18 Maximum Channel Power of 2 Channels Located at Current Zone Fill Levels (kW)

Rule # 19 Maximum Channel Power of 4 channels located above or below Current Zone Fill Levels (kW)

Rule # 20 Maximum Channel Power of Next 6 Channels Located near Current Zone Fill Levels (kW)

The last three rules are not elimination rules but selection criteria. If one of these rules were to fail because of a high powered channel in the vicinity of a zone level, that zone could not afford to drain for fear of allowing that channel power to increase further. Thus, on the failure of one of these rules, the program increases refuelling requirements for the two zones closest to the high-powered channel, to reduce the risk of the zones draining and local power rising.

2.2 REFINING OF THE ELIMINATION RULES

A recursive feature has been built into this selection process in order to obtain a certain number of candidate channels. The number of channel candidates required for the channel selection process is user defined. The rules should be initially defined to produce 10% of the candidates required for the final selection process. This is because part of the ordering technique defined in section 3.3 depends on how soon a channel qualifies for refuelling under less stringent conditions.

If there are not enough candidates, the minimum required acceptance of all of these rules is relaxed by the increment listed in Table 1 to allow for more candidates to qualify. This procedure is repeated until there are at least the minimum required candidate channels remaining after elimination. It is also possible that there will be more qualifying channels than needed. In this situation, the minimum required acceptance criteria for each rule is made more stringent to eliminate more channels from further consideration.

The rules listed above are initially assigned values by the user that are intended to eliminate over 98% of the total channels and leave between 3 and 7 as candidates in the 380 channel NU core. Since about 10 times that minimum number of channels are required for the next stage, the conditions set by the rules must be relaxed to allow more channels to qualify.

2.3 COUNTING THE REFUELLINGS IN EACH DIRECTION BY ZONE

The program has the user defined option to automatically balance the number of refuellings in each direction for each pair of zones. The program reads in all the channels refuelled over a user defined period, and increments a counter in each direction for each pair of zones for each channel refuelled in that direction. The user can define the number of FPD previous to the current FPD for which the refuellings must be balanced in each direction for every front-to-back pair of zones.

For CANDU 6 reactors, the number of channels fuelled in each direction is not equal for every front-to-back pair of zones. In this case, for every pair of zones, the program will count the number of channels with fresher fuel at each end of the core. It will then try to match the ratio of front-to-back refuellings to the ratio of channels fuelled from each end of the pair of zones, over the user-defined period.

2.4 ORDERING OF CANDIDATE CHANNELS FOR REFUELLING

The channel candidates are first put into groups corresponding to the seven pairs of zones (the front and back halves of the reactor). The zones are also ordered by the number of candidates in each pair of zones. The first pair of zones is determined to be the one with the lowest average zone fill level.

If two pairs of zones have the same number of candidates, the zones are weighted by the corresponding average zone level. Preference is given to candidates associated with the lower zone levels. The front-to-back tilt is controlled by refuelling in the direction of increasing zone levels. This is determined by comparing the front to back zone levels with that of the previous FPD. Preferential refuelling can only be done on a limited basis without creating oscillatory behaviour. Thus, the candidates will be preferentially ordered to balance the number in each direction, if at least two refuellings have occurred in one direction more than in the other.

The channel candidates are then sub-ordered within each zone, by the number of times the rule selection criteria have had to be relaxed in order to increase the total number of candidates. The preferred candidates are the ones which qualified under more stringent selection criteria. Finally, if two channels qualify identically under the above criteria, the candidate with the higher K-increase will be selected. This criterion also maximizes fuel burnup, since channels with high values of K-increase are usually also the older (more burnt-up) channels.

2.5 SELECTION OF CHANNELS TO BE REFUELLED

The program now enters the SELECHAN routine to choose the best candidates from this ordered list to be refuelled over the next FPD. The first stage of this selection process is to determine the optimum number of channels to be refuelled. This is achieved by setting requirements for the optimum zone levels.

The first step is to add extra refuelling requirements to zones for which there is a high power channel near the location of the current fill level. This is achieved by assuming the current zone levels are reduced by one lattice pitch. This will in turn increase the requirements to refuel a channel in that zone if a candidate exists. The object of these rules is to prevent a drop in some zone levels if there is a chance that a high powered channel near that zone compartment will exceed channel power limits. The definition of a high powered channel near a zone fill level is given in Table 2 under the rules numbered 18, 19 and 20. A picture of the affected channels relative to the zone controller compartment is shown in Figure 4.

The next step is to determine the zone levels for the next full power day without refuelling, and compare this to the nominal zone level. Finally, this difference in zone levels is converted to reactivity, recorded in a DELTA array (a value for each zone) with units of µk, which is the units of measurement for the K-increase array. If the anticipated zone level after an FPD without refuelling is still higher than the nominal zone level, it will have a positive DELTA, signifying that no more refuelling is needed. For every zone that requires refuelling, the DELTA will be negative.

Now, the channel candidates can be chosen for channels in all pairs of zones for which both DELTA(i) and DELTA (i+7) are negative. The K-increase for both the front half and the back half of the selected channel is added to DELTA(i) and DELTA(i+7) respectively, to measure the effectiveness in re-establishing the zone levels to their nominal levels. If either DELTA(i) or DELTA(i+7) becomes positive, no more channels in that pair of zones will be refuelled.

Once a channel is chosen, all other candidates within $\sqrt{3^2 + 1^2}$ lattice pitches are eliminated from further consideration. Any other candidates within $\sqrt{5^2 + 1^2}$ lattice pitches are marked, where a second mark will eliminate them also from further consideration. This is to reduce the risk of several channels being picked in close proximity of each other and causing a local hotspot.

2.6 REFINING OF SELECTION CRITERIA

For different reactors and different fuelling schemes, the number of channels to be refuelled each FPD can be significantly different. Thus, there is a user defined option in the input file to set the number of channels to be refuelled within certain limits above and below the core average value for each day of the week. After the program has gone through the entire list of refuelling candidates, it counts the number of selected channels.

If less than the minimum required number of channels are to be refuelled, the program will increase the required zone fills by 0.2 %, and repeat the selection process. This effectively increases fuelling requirements by 12 µk, or about 1 µk for the DELTA(i) of each zone, allowing more channel candidates to qualify for refuelling. If more than the maximum required number of channels are to be refuelled, the program will reduce the zone fills by 0.3 %, and then repeat the selection process. This in turn produces less negative DELTA(i)s, allowing less channel candidates to qualify for refuelling.

The reason for choosing a minimum and maximum number of channels to be refuelled every FPD is partly for stability of fuelling cycles, and partly to keep the work-load of the fuelling machine fairly consistent. Rules 18 to 20 are unaffected by the refining process of the final selection. When the iteration has selected between the minimum and maximum number of channels, the program will leave the SELECHAN routine.

2.7 CREATION OF RFSP INPUT FILE

Once the channels to be refuelled have been chosen, the program creates a new RFSP input file with this data, for the refuelling simulation of the next FPD. The input file is built line by line from an RFSP input template file. All required variables will be set by the program and inserted in integer format into the new input file.

The program does not keep a record of previous refuellings. The RFSPINP routine opens the RFSP input of the most recent FPD, and reads all the previous refuelling information contained on those S and R cards back to the point where the last mass-storage file was created. These are written directly into the new RFSP input file. On those occasions when the mass storage file was created in the previous run, the previous RFSP input is not required or even opened.

If everything is properly executed, and the program has copied the *CLOSE line into the new input file, the program will then terminate normally, and the batch file will immediately execute RFSP using the input file created here.

3. USING REFUEL

3.1 EXECUTING REFUEL

The REFUEL program can be run separately using the command "refuel.hp" on the HP computers, but it is most useful within the "refuel" batch file which executes the REFUEL program and RFSP program consecutively.

This batch file requires two input parameters for execution, the first Full-Power-Day of the calculation and the last Full-Power-Day of the calculation. The batch file will loop through this range one FPD at a time, writing this parameter directly into the input file before execution. The REFUEL code is executed once for each Full-Power-Day. The RFSP code is executed after each case and used as input to the next REFUEL calculation, and to determine the maximum channel and bundle powers for each FPD.

The "refuel" batch file requires the RFSP output file that is to be used as the starting point, to contain output generated by the *PRTPWR module of RFSP. The RFSP and REFUEL executables should also be present in this directory, as well as a time-average case and several other template files.

3.2 REFUEL INPUT FILES

The REFUEL code uses the input and output from the previous RFSP simulation and an RFSP time-average output. All these files are automatically copied into the locations where the program will find them for the next iteration through the batch file. Several other files are also required, including the template of the input file shown in Figure 5 and Table 3, the primary zone of each channel, and the fuel scheme for each channel. Eventually, all required data will be extracted directly from one direct-access file of RFSP.

The program needs several files to be present in the current directory for proper execution, including "zonescheme", and template files like "refuel.380inp" and "fpdold.in". A *PRTPWR representation of the time-average case must also be in the same directory, as well as the most recent mass storage file.

3.3 OUTPUT FILES OF REFUEL

The output generated by REFUEL is given in four forms. The screen output contains output from the ELIMIN, ELIMORD, SELECHAN and RFSPINP routines at the end of each pass through the refining stage, culminating with the selection of the channels to be refuelled. The standard output is called "refuel.out" and it includes a copy of all the input and most of the steps taken to produce the final output, which is a list of channels to be refuelled for the next full-power-day. The batch file moves the main output "refuel.out" to an FPD specific name for which the channels are to be refuelled.

A special output called "refuel.test" includes all the steps taken to determine the list of channels to be refuelled for the next full-power-day. This is overwritten every time the REFUEL program is executed, but it can be used for customizing the refuelling rules when developing the template of the input file for a new reactor. The final output is the actual RFSP input file used to run the next FPD refuelling calculation.

4. VERIFICATION

REFUEL has been successfully used to perform refuelling simulations for the CANDU 6 core. The program is able to maintain the maximum channel power, the maximum bundle power and the maximum refuelling power ripple to below the specified limits for over 600 FPDs (the total period simulated).

Previous versions of this code have also successfully simulated refuellings over 500 FPD in a CANDU 9 480/SEU core, and 600 FPD in a CANDU 6 core using DUPIC fuel. Refuellings of a 480NU core and a 380NU core have also been simulated over 500 FPD. For the NU core simulations, the maximum bundle power over this period was below 900 kW and the maximum channel power over this period was below 7000 kW. None of the zones drained to the pre-set limit of 20%, or filled to the pre-set limit of 80% over the entire period. No cases even had to be repeated to maintain those limits.

5. CONCLUSIONS

The REFUEL program is a useful utility with a simple structure that can be modified to refuel any type of CANDU reactor. The program is automated to produce an RFSP input file to simulate refuelling of the next FPD, and to execute RFSP with that input to produce an output file that is ready for use in the next refuelling step. This is all possible with the simple command "refuel #" where # is a four-digit full-power-day for which the RFSP input and output of the previous FPD exists.

A major benefit of this program is to be able to generate a large amount of snapshot data quickly, to determine compliance to Stress-Corrosion-Cracking (SCC) limits for various fuelling schemes, by running 500 FPD simulations over a weekend.

The program has been successfully used to perform extensive refuelling simulations in 480-channel and 380-channel CANDU reactors using natural and enriched fuel. The code can easily be adapted to choose the optimum channels for any CANDU reactor. The current code design allows each reactor type with a unique number of channels and layout to be incorporated by a small adjustment in a peripheral routine. However, this would change the version number, and would require updating of the documentation.

6. REFERENCE

1. B. Rouben, "Overview of Current RFSP-Code Capabilities for CANDU Core Analysis", Paper presented to the 1995 ANS Conference in Philadelphia.

Figure 1 : Flowchart for the REFUEL Program

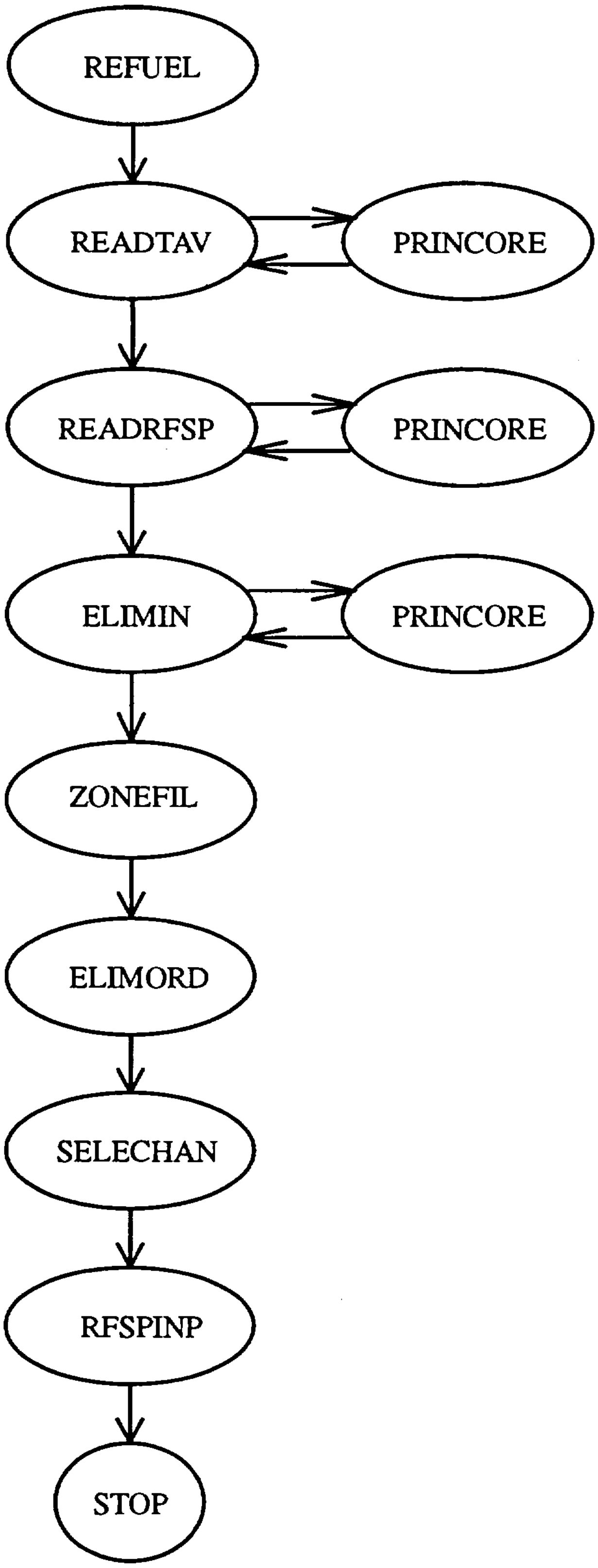
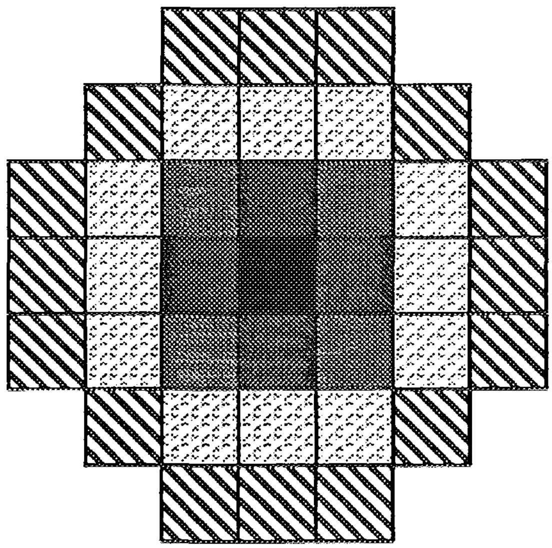


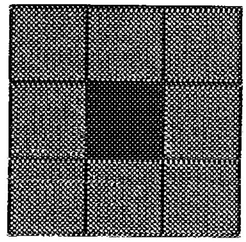
Figure 2 : Channel Neighbours Affected by High Power Rules



Legend :

- Channel Candidate
- First Neighbour Channel (Rules 6 and 10)
- Second Neighbour Channel (Rules 7 and 11)
- Third Neighbour Channel (Rules 8 and 12)
- Fourth Neighbour Channel (Rules 9 and 13)

Figure 3 : Channels Affected by Last Refuelling Rules (14, 15)

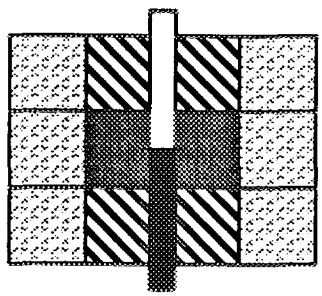


Legend :

Channel Candidate (Rule # 14)

Eight Immediate Neighbours (Rule # 15)

Figure 4 : Channels Affected by Zone Level Proximity Rules (18, 19, 20)



Legend :

Zone Controller Compartment (White Part is Filled with Air
Black Part is Filled with Light Water)

Channels at Current Zone Fill Levels (Rule # 18)

Channels Above or Below Current Zone Levels (Rule # 19)

Channels Near Current Zone Levels (Rule # 20)

Figure 5 : REFUEL.INP File for FPD 500 of CANDU 6 Core

```
bundlim =  840.
chanlim =  6950.
energy =   2061.4
  10    Step size between succesive refuellings
 200    Zone Balance (FPD)
   0    Last Sunday
 25 35  Minimum, Maximum Number of channel Candidates
  0  2  0  3  0  2  0    Minimum Number of channels Refuelled per day of week
  0  6  2  3  2  6  0    Maximum Number of channels Refuelled per day of week
Rows,Cols:   22
 A B C D E F G H J K L M N O P Q R S T U V W
01020304050607080910111213141516171819202122
 9 6 5 4 3 3 2 2 1 1 1 1 1 1 2 2 3 3 4 5 6 9
14171819202021212222222222222121202019181714
# of Zones   14
  5  5 11 11 11 17 17  5  5 11 11 11 17 17
 10.0  18.0   6.0  13.0  20.0  10.0  18.0
 10.0  18.0   6.0  13.0  20.0  10.0  18.0
  8.5   8.0   7.5   7.0   7.0   8.5   8.0
  8.5   8.0   7.5   7.0   7.0   8.5   8.0
RULE Enabler, Starting Value, Increment (in %). MUST BE 20 RULES IN CORRECT ORDER
T  6100.    0.1   Channel Power Too High
T  6700.    0.1   K-Increase Factored Channel Power Too High
T   750.    0.1   Bundle Power Too High
T   820.    0.1   K-Increase Factored Bundle Power Too High
T   955.    0.1   Maximum Channel Ripple
T  6600.    0.1   First (4) Neighbours of High Powered Channel
T  6650.    0.1   Second (4) Neighbours of High Powered Channel
T  6700.    0.1   Third (12) Neighbours of High Powered Channel
T  6800.    0.1   Fourth (16) Neighbours of High Powered Channel
T   830.    0.1   First (4) Neighbours of High Powered Bundle
T   835.    0.1   Second (4) Neighbours of High Powered Bundle
T   840.    0.1   Third (12) Neighbours of High Powered Bundle
T   845.    0.1   Fourth (16) Neighbours of High Powered Bundle
T   100.   -0.4   Burnup (Percentage of Time Average)
T   150.   -0.4   Last Refuelling (days before current)
T     6.   -0.4   Last Refuelling of immediate neighbours (in days)
F     1.          CANDIDATES ELIMINATED BY PREVIOUS TEST RUN
T  6650.          Channel Powers over current Zone Fill Levels
T  6700.          Channel Powers of First (4) Neighbours of current Zone Fill Levels
T  6750.          Channel Powers of Second (6) Neighbours of current Zone Fill Levels
FPD added below:
499
```

TABLE 1

ELIMINATION RULES (Used for the CANDU 6 Core)

RULE No.	RULE DESCRIPTION	RLIMIT Value	INCREMENT to Increase Candidates
1	Maximum Channel Power	6100 kW	0.1 %
2	Estimated Maximum Rippled Channel Power	6700 kW	0.1 %
3	Maximum Bundle Power	750 kW	0.1 %
4	Estimated Maximum Rippled Bundle Power	820 kW	0.1 %
5	Rippled Channel Power over Time-Average (x 1000)	955	0.1 %
6	First (4) Neighbours of High Powered Channel	6600 kW	0.1 %
7	Second (4) Neighbours of High Powered Channel	6650 kW	0.1 %
8	Third (12) Neighbours of High Powered Channel	6700 kW	0.1 %
9	Fourth (16) Neighbours of High Powered Channel	6800 kW	0.1 %
10	First (4) Neighbours of High Powered Bundle	830 kW	0.1 %
11	Second (4) Neighbours of High Powered Bundle	835 kW	0.1 %
12	Third (12) Neighbours of High Powered Bundle	840 kW	0.1 %
13	Fourth (16) Neighbours of High Powered Bundle	845 kW	0.1 %
14	Burnup Percentage of Time-Average	100 %	–0.3 %
15	Last Refuelling (days before Current)	150 Days	–0.3 %
16	Last Refuelling of 8 Immediate Neighbours (days)	6 Days	–0.3 %
17	Selected Channels : Tested Power too High		n/a

TABLE 2

SELECTION RULES (Used for the CANDU 6 Core)

RULE No.	RULE DESCRIPTION	RLIMIT Value	PROXIMITY to ZONE FILL LEVEL
18	Channel Powers At Zone Fill Locations	6650	0.5 Lattice Pitches
19	Channel Powers Near Zone Fill Locations	6700	1.1 Lattice Pitches
20	Channel Powers Near Zone Fill Locations	6750	1.8 Lattice Pitches

TABLE 3 : CONTENTS OF "refuel.inp" (Used for the CANDU 6 Core)

INPUT DATA	Name of Variable	Format
Bundle Power Limit (kW)	BUNDLIM	10x, F8.0
Channel Power Limit (kW)	CHANLIM	10x, F8.0
Reactor Power (MW)	ENERGY	10x, F10.2
No. of FPD between successive records on Mass Storage File	ISTEP	I4
No. of FPD over which to balance the number of zone pair front-to-back refuellings	IBALANCE	I4
FPD of Last Sunday	LSUNDAY	I4
Minimum, Maximum # of Channel Candidates	MINCAND, MAXCAND	2I3
Minimum # of Channels to be Selected (For each day of week)	MINSEL(iday),iday=1,7	7i3
Maximum # of Channels to be Selected (For each day of week)	MAXSEL(iday),iday=1,7	7i3
No. of Rows, Columns	NDIM	15x, I5
Row Identifiers	ROW(i), i=1,NDIM	24A2
Column Identifiers	COL(i), i=1,NDIM	24A2
Core matrix Start of Channels in Row	IBEG(i), i=1,NDIM	24I2
Core matrix End of Channels in Row.	IEND(i), i=1,NDIM	24I2
Number of Zones	14	
Core Column to the Left of each Zone Location	ZCOL(i),i=1,14	14I3
Bottom Core Row of Each Zone	ZROW(i),i=1,14	7F6.1
Length of Each Zone	ZLEN(i),i=1,14	7F6.1
Number of Rules	NRULE	7F6.1
Rule Activator ("T" or "F") , Rule Limit, Rule Increment, Rule Definition	(RULE(i),RLIMIT(i), RINC(i) TEXT(i), i=1,NRULE)	L1, F9.2, F6.2, A72
Full Power Day (Added by "refuel" Batch File)	IFPD	/,I4
No. of Channels Exceeding Power Limits (Added by "refuel" Batch File)	NELIM	I3