JSE DERIVATIVE MARKETS MARGINING: TECHNICAL SPECIFICATIONS

This document contains the technical specifications of the MARK-TO-MARKET and MARGINING processes used by all JSE derivative markets. It is intended for systems people writing programs for use on the derivatives markets. The sister paper "An Overview of Safex Margining Methodology", gives a brief but comprehensive summary of the margining process.

Contents

[§] **Not included: never implemented.**

[¶] **Not included. Available from www.jse.co.za/Markets/Interest-Rate-Market.aspx.**

Version 3.03, the previous version was dated 31 March 2011. That version was updated to include new products like the Can-Do structured futures.

This version, 3.04 was necessitated due to the growth in the type of instruments traded on the different derivatives markets of the JSE.

The original document was drafted during June 1992 when equity and bond derivatives were the only instruments traded on the market known as SAFEX. SAFEX introduced futures and options on grains during 1998. The JSE acquired SAFEX during 2001 and since then a whole host of new instruments like currency derivatives, metal derivatives, oil derivatives and Jibar futures started to trade on the relevant derivatives markets: equity derivatives, commodity derivatives, currency derivatives and interest rates.

This document describes the margining procedures for all derivatives instruments traded on the JSE's 4 derivatives markets. It thus encompass the margining for all derivatives instruments traded on the 4 derivatives markets.

Preface to the Fifth Edition

This document grew out of the Documentation Paper, "Technical Specifications", Version 2 [1], dated 13 June 1992, of the Safex Options Project Documentation Pack.

The Documentation Pack was a body of papers produced at the time when Safex listed options on futures and introduced its Portfolio Scanning margining method. It provided a number of perspectives on the new market, at varying levels of detail.

With the market now having been fully-fledged for some time, many of those introductory papers are superfluous. Indeed, quite a few have been superceded by events. Nevertheless, Safex will make the Documentation Pack available to those requesting it, on the understanding that it is provided to give a general background to the markets, and is in many places not to be taken literally.

Those interested in a detailed, accurate, up-to-date description of Safex's present mark-to-market and margining should read this paper together with the general introduction in the paper "An Overview of Safex Margining Methodology".

This is the fifth edition of the technical specification. However, it is not a new version. It is merely an update of Version 3.03 to incorporate all the new markets that developed since 1992. The main changes made to Version 3.02 to produce Version 3.03 are:

- From the start of the derivatives market it was always assumed that no contract can have a value of less than zero. Hedge funds are now trading structured derivatives on the JSE that can have a negative value. Such Can-Do baskets consist of long and short positions. To incorporate these trades and ensure that the correct margins are applied, Section 4.3.1 has been updated.
- IMR calculation of Can-Do exotic options are noted in Section 4.10.
- Equation (24) on page 27 had an error. This is rectified.

The main changes made to Version 3.03 to produce Version 3.04 are:

- Every reference to SAFEX should be read as pertaining to all instruments traded on any of the 4 derivatives markets: equity derivatives, commodity derivatives, currency derivatives and interest rate derivatives.
- When reference is made to an ALSI future or option it might as well be a WMAZ, CORN, OILS, ZAUS, ZAEU, single stock or Can-Do future or option.
- No changes have been made to the technical details as set out in Version 3.03.

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[1]   Hereinafter referred to as "Version 2".

SYNOPSIS

Risk management may be defined as identifying the risks of loss in a portfolio and ensuring that the losses can be borne.

In the case of a futures exchange, risk management is performed in two steps: marking-to-market and margining.

Marking-to-market ensures that all losses up <u>to the present</u> are absorbed. Participants with losses are required to make cash payments to the exchange equal to their losses.

Margining then estimates what losses are possible <u>in the future</u>. Participants are required to lodge margins with the exchange which are sufficient to cover these possible future losses. Should the losses eventuate and the participant be unable to bear them, the margin is available to the exchange to meet the shortfall.

There are two stages to estimating possible future losses:

> The exchange first defines a number of extreme market scenarios. These are based upon a statistical analysis of historical market moves and subjective assessments of the state of the market. They express the maximum anticipated price and volatility moves between the present and the next mark-to-market day. To be realistic, they can also allow for the correlations between the prices of different futures contracts. The parameters defining the scenarios are called Margin Requirements.

> Secondly, the exchange revalues each position under each scenario. The revaluation is a matter of calculating the mark-to-market profit or loss that the position would suffer, at the next mark-to-market day, assuming that by then the scenario had come to pass. The maximum of all these losses is the margin for the position. The margin covers the maximum conceivable mark-to-market loss that the position could suffer.

The control of the risk exposure of the exchange is in its hands. Its "handles" on the risk management process are its ability to change the Margin Requirements. In times of uncertainty or high volatility, it can make the scenarios more extreme, hence covering a wider range of outcomes. Margins will be higher as a result. In quiet times, the scenarios can be relaxed. At all times, the exchange will want to be confident that it has allowed for the sudden unanticipated shocks which characterise the markets.

It also wants to be satisfied that the stipulated Margin Requirements will lead to proper margining of positions. This is an issue of methodology. The methodology must take Margin Requirements and, by applying them to positions, according to rigorous, public procedures, produce fair and reliable margins. The aim of this paper is to describe precisely that methodology, so that anyone writing programs to implement it will arrive at the same results that Safex itself gets.

SECTION 1: MARGIN REQUIREMENTS

The following is a list of the Margin Requirements set by the Exchange's Risk Management Committee, RMCO. These are subject to daily change; Appendix B describes the layout of the files containing their current values. By changing their values, RMCO can react to changing market conditions, and determine the overall stringency of margins throughout the Exchange.

1.1.   The Risk Parameter ("RiskParm"). This parameter expresses RMCO's basic attitude to risk. It is set at 3.5 standard deviations, equivalent to a 99.95% confidence level. It only appears in these specifications in Equation (7) of Section 4.2.4; its main use is in setting the remainder of the Margin Requirements, an ongoing process of statistical analysis at the Exchange.

1.2.   Initial Margin Requirement ("IMR"). There is an IMR for each futures contract (ie for each expiry month on each underlying, referred as a "Class"). A futures contract's IMR is equal to the profit or loss arising from the maximum anticipated or feared up or down move in its price from one day to the next. It is given in Rands per futures contract. The margin of a straight, single-contract, futures position, involving no options and ineligible for offsets, will be equal to the Initial Margin Requirement of its futures contract.

1.3.   Volatility Scanning Range ("VSR"). Each "Series" of contracts (ie all expiry months on the same underlying) has a VSR. This is the size of the volatility half-range over which options are valued during the margining process. It expresses the maximum increase or decrease in volatilities due to supply and demand factors, rather than price movements in the underlying contracts.

The next two sets of Margin Requirements deal with the offset of margins.

1.4.   Class Spread Groups ("CSGs") and Class Spread-Margin Requirements ("CSMRs"). RMCO determines which Classes (ie contract months) in a Series of contracts are to be eligible for offset margining. These Classes form a CSG. RMCO then stipulates a CSMR for each Class in a CSG. This is a Rand amount expressing the maximum loss which could be expected from a failure of the Class's price to move perfectly in-step with the prices of other Classes in the group.

1.5.   Series Spread Groups ("SSGs") and Series Spread-Margin Requirements ("SSMRs"). Similarly, RMCO may allow offset of margins between different Series of contracts: eg between the ALSI, FNDI and INDI Series. These then comprise an SSG, each member of which has its SSMR, with the same meaning as given in 1.4.

Margin Requirements are published daily by the Exchange. Together with mark-to-market prices and volatilities, they are the basic exogenous data required by participants to calculate their margins for themselves; the only additional information being, of course, the participants' own positions.

SECTION 2: DEFINITIONS, TERMINOLOGY AND NOTATION

An Exchange Contract, according to the Rules of Safex, is a futures contract or an option contract which is "included in the list of financial instruments to be kept by the executive committee in terms of the [Financial Markets Control] Act."

The list is a detailed, one-by-one list of all instruments, futures or options, traded on the Exchange at any time.

For our purposes, it will be necessary to refer to Exchange Contracts by the parameters classifying and defining them:

2.1   A Contract is an Exchange Contract, either a futures or an option contract, specified as:

$$C_{u,e,t,k}$$

where the parameters of the contract are:

u,	the underlying financial instrument on which the futures contract $C_{u,e}$ (see below) is defined; [1]
e,	the expiry month or date;
t,	the type of an option contract, either put or call;
k,	the strike price of an option contract.

The usage $C_{u,e,t,k}$ can refer to either a futures or an option contract:

When it refers to a futures contract, the values of t and k are deemed to be null; or, alternatively, are omitted to result in the specification of a futures contract as $C_{u,e}$. When it is necessary to refer specifically to a futures contract in the text, the terms "futures contract" or "future" will be used.

When $C_{u,e,t,k}$ refers to an option contract, all parameters are required. An option contract $C_{u,e,t,k}$ is an option to buy (t = call) or to sell (t = put) its underlying futures contract $C_{u,e}$ at the strike price k. The expiry date of an option contract is the same as the expiry date, e, of its underlying futures contract. All options are American style. A specific reference to an option contract in the text will be via "option contract" or "option".

"Contract" in the text refers to either an option or a future.

Examples:

$C_{ALSI,\ 20\ Mar\ 98}$	is the March 1998 ALSI futures contract.
$C_{INDI,\ 20\ Jun\ 97,\ Call,\ 8000}$	is the option contract to buy the June 1997 INDI futures contract for a price of 8,000 at any time up to and including the expiry of the futures contract.

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[1] Note that u itself is not an Exchange Contract, but is the exogenous instrument, eg the JSE's All Share Index (ALSI), Republic of South Africa Loan 150 (R150), or a (notional) 91¼ day Bank Bill (BBF3), on which an Exchange Contract is defined.

The subscripts u, e, t and k can be either in upper or lower case. An upper case subscript indicates that, in the context, the parameter specified by that subscript is fixed. A lower case subscript implies that the parameter can vary over all values which produce a valid Exchange Contract.

Subscripts may be omitted where the context allows them to be understood.

2.2   A Class, $CL_{U,E,t,k}$ or $CL_{U,E}$ of contracts, is the futures contract $C_{U,E}$ and all options $C_{U,E,t,k}$ defined on it.

Example:

$CL_{GLDI, 19\,Dec\,97}$ is the Class consisting of the December 1997 GLDI futures contract, and all options which will be listed on it.

2.3   A Series, $S_{U,e,t,k}$ or S_U of contracts is the set of all futures and options listed on the same underlying financial instrument U.

Example:

S_{ALSI} is the Series of all ALSI futures contracts, with expiry months Near, Middle, Far and Special, listed at any time, plus all options listed on any of these futures.

2.4   A Price, $P_{u,e,t,k}$, of a contract is a number expressing, in units specific to the contract, its price or quotation in the market. The units apply to quotations on the screens, to prices at which deals are reported, to mark-to-market prices, and to the putative scenario prices which are calculated during the margining process. Hence, according to this definition, the *Price* of an interest-rate contract (all of which are traded on yield) is the yield itself.

Note that the strike price, k, of an option $C_{u,e,t,k}$ is a price of its underlying futures contract, $C_{u,e}$, and hence is denominated in the same units.

2.5   The Value, $V_{u,e,t,k}$, of a contract is the nominal monetary value of one contract, expressed in Rands. V is also regarded as the function which converts from price to value:

$$V_{u,e,t,k} = V_{u,e,t,k} (P_{u,e,t,k})$$

The value function V (•) may be simple (eg multiply Price by 10 for an Equity Index Future) or complicated (eg the use of the Gilt Clearing House formula to find the value of an R153 future from its price, which is quoted as a yield). The Value Functions of all futures contracts listed on the Exchange are given in Appendices C and D.

Options are quoted directly in Rands per option, and hence their value functions are even simpler: the value is equal to the price.

Values are expressed in whole Rands per Contract. If the value function gives a fractional result, it must be rounded according to the specifications of the contract, as given in Appendices C and D.

2.6   The Position, $N_{u,e,t,k}$, of a participant in a contract $C_{u,e,t,k}$, is the number of contracts which the participant holds. A positive integer denotes a long position, a negative integer a short one. N=0 implies that the participant does not have a position in the contract.

2.7   The Black Option Pricing Formula, BLK, is the formula, specified in Appendix A, for calculating a theoretical value, V, of an option $C_{u,e,t,k}$ on a future, from the details of the option and at a given volatility and futures price:

$$V = BLK [F, K, \sigma, T, t]$$

where:

F   is the value of one contract of the option's underlying future at the given price , $P_{u,e}$:

$$F = V_{u,e} (P_{u,e});$$

K   is the value of one contract of the option's underlying future at the option's strike price, k:

$$K = V_{u,e} (k);$$

σ is the given volatility, expressed as a percentage[1] per annum;

T   is the time to expiry of the option, expressed in whole days. If the option's expiry date, e, and the current date, T_0, are expressed as the number of days since some fixed base date, then $T = e - T_0$;

t   is the option type.

The implementation of BLK described in Appendix A produces a result, V, rounded to the nearest whole Rand.

<u>Rounding</u>

Except where explicitly stated otherwise, all calculations are carried out, and all intermediate results are stored, to full precision. At least 12 decimal places of accuracy are required. The standard double (or, indeed, extended) precision of Intel chips and the 64 bit double words of Personal Computers are quite adequate. The old "single precision" of FORTRAN compilers, at 6-7 decimal places and 32 bits, is not.

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[1]   Where a number is expressed as a "percentage", it must be divided by 100 before being used in any calculations. So, "15%" or "15 per cent" or "15" (where it is stated that it is expressed as a percentage) all refer to the decimal number 0.15.

SECTION 3: MARK-TO-MARKET

Mark-to-market of futures and options positions proceeds in exactly the same way. The position brought forward is marked from the previous to the present mark-to-market price. Then all deals for the day are marked from their deal price to the present mark-to-market price. The amounts from each step are added to give the total mark-to-market profits or losses due to or from the participant in respect of his positions.

Two special deal types related to options are *exercise* and *assignment*. An exercise refers to the reduction in a long option position that occurs when its holder chooses to exercise his rights under the option. An assignment is the corresponding reduction in the short option position of a holder who, by a random process[1], is determined by the Exchange to be (one of) the persons whose options are exercised.

In both cases, the holders' positions are also changed to reflect the buying or selling of futures at the option's strike price. These resulting futures transactions are called the *exercising (futures) transaction* and the *assigning (futures) transaction* respectively.

3.1   Data Required.

Let:

$N' = N'_{u,e,t,k}$ be the brought forward position of a participant in the contract $C = C_{u,e,t,k}$;

$V' = V'_{u,e,t,k}(P'_{u,e,t,k})$ be the previous mark-to-market price and value of C;

$V = V_{u,e,t,k}(P_{u,e,t,k})$ be the present mark-to-market price and value of C.

Now let:

$$\{ n_i, p_i \}, \quad i=1,2,...J$$

denote matched deals, option exercises and assignments in the contract C ("transactions") for the period,

where:

J	is the number of transactions;
n_i	is the number of contracts C bought, sold, exercised or assigned in transaction i;
p_i	is the price of transaction i.

If transaction i is a deal (including an exercising or assigning futures transaction):

n_i is a positive integer for a purchase, and a negative integer for

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[1]   Options being exercised are assigned to holders of short positions in the option pro-rata to the size of their positions. Randomness is used only to allocate the fractional assignments which usually result from a direct pro-rating.

a sale[1].

If transaction i is an exercise or assignment:

n_i	is a positive integer if the transaction is an assignment;
n_i	is a negative integer if the transaction is an exercise;
p_i	is zero.

3.2 Results to be Calculated.

Let:

$N = N_{u,e,t,k}$ be the carried forward position of the participant in contract C;

$MtM = MtM_{u,e,t,k}$ be the mark-to-market profit (positive) or loss (negative) of the participant's position in C.

3.3 Mark-to-Market.

Mark-to-market is achieved by applying the following two formulae to all positions.

The position carried forward is the algebraic sum of the position brought forward and all purchases, sales, exercises and assignments:

The Position Formula

$$N = N' + \sum_{i=1}^{J} n_i$$

The mark-to-market profit or loss is the sum of the individual profits or losses on the position brought forward and arising from each transaction:

The MtM Formula

$$MtM = N' \cdot (V - V') + \sum_{i=1}^{J} n_i \cdot \left(V - V_{u,e,t,k}(p_i)\right)$$

3.4 Open and Closed Positions.

This section derives two useful results from the MtM Formula. These prove that the formula acts as intuition expects it would; and will be necessary in the discussion about option premiums and exercise in Section 3.5 below.

3.4.1 Open Positions.

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[1] See Table 1 below for the rules determining whether an exercising or assigning transaction is a purchase or a sale, ie for the sign of n_i in these circumstances.

Consider a participant with a position of N contracts C acquired at a price and value given by $V_0 = V (P_0)$. N can be positive (a long position) or negative (a short position); C can be a future or a call or a put.

Let the contract's mark-to-market value on the first day be V_1. The mark-to-market profit or loss for the first day, MtM_1, from the second term of the MtM Formula, will be:

$$MtM_1 = N . (V_1 - V_0)$$

Similarly, the market-to-market profit or loss on the second day, from the first term of the MtM Formula, is:

$$MtM_2 = N . (V_2 - V_1)$$

and on the m'th day:

$$MtM_m = N . (V_m - V_{m-1})$$

where V_i is the mark-to-market value on the i'th day.

The participant's cumulative mark-to-market profits or losses up to the m'th day, CUM_m, are the sum of the mark-to-market profits or losses from day 1 to day m:

$$CUM_m \sum_{i=1}^{m} MtM_i$$

which reduces to:

$$CUM_m = N . (V_m - V_0) \tag{1}$$

Hence cumulative mark-to-market profits and losses of a still-open position are a function only of the original purchase price and value and the most recent mark-to-market price and value. This holds whether the contract is an option or a future, whether the position is long or short.

3.4.2 Closed Positions.

Now let the position be closed on day m, at price and value $V_c = V (P_c)$. This implies a transaction of -N contracts, with -N being substituted into the second term of the MtM Formula. Together with the marking-to-market of the position brought forward (the first term), this gives the participant's mark-to-market profits or losses for the m'th day as:

$$MtM_m = N . (V_m - V_{m-1}) + -N . (V_m - V_c)$$

which simplifies to:

$$MtM_m = N . (V_c - V_{m-1}) \tag{2}$$

The cumulative mark-to-market profits or losses are:

$$CUM_m = CUM_{m-1} + MtM_m \tag{3}$$

The first term of equation (3) is obtained by putting m-1 in the place of m in Equation (1); the second term comes from Equation (2):

$$CUM_m = N \cdot (V_{m-1} - V_0) + N \cdot (V_c - V_{m-1})$$

which gives

$$CUM_m = N \cdot (V_c - V_0) \tag{4}$$

Therefore, net mark-to-market profits or losses on a closed position are a function only of the original price and the closing-out price - for both futures and options, and for long and short positions.

3.5 Option Premiums and Exercise.

This section uses the results of 3.4 to illustrate how option premiums are paid, and how profits are reflected on option exercise.

3.5.1 Open Positions.

The treatment of these follows directly from Equation (1) of Section 3.4.1 above. The cumulative profit or loss depends only on the premium and the most recent mark-to-market value. The important aspect of Equation (1) is that it preserves a "memory" of the option premium, V_0. If the option is held to its expiry, the premium will be realised, as shown in the sections below.

3.5.2 Positions Closed in the Market.

An option position can be closed in three different ways. This section deals with the first of those three ways; sections 3.5.3 and 3.5.4 below deal with the other two ways. For all of these, the relevant Equation is Equation (4), for Closed Positions.

The first way an option position can be closed is by an offsetting purchase or sale of the option in the market.

In this case V_c in Equation (4) is the price of the closing purchase/sale. The participant has realised the change in market value of his option over the period for which he held it. This is exactly analogous to the taking and closing of a position in a futures contract. The total value of the contract does not change hands - just as it does not in the purchase and sale of a futures contract. Rather, the <u>change in value</u> is realised through the mark-to-market process.

3.5.3 Lapse.

Secondly, a position in an out-of-the-money option will lapse at expiry.

Out-of-the-money options have no value: V_c in Equation (4) is zero. Therefore the cumulative profits or losses are:

$$CUM_m = - N \cdot V_0$$

If N is positive, the position was long, and the losses are equal to the number of options in the position times the price, V_0, at which they were acquired. The premium has been paid.

If N is negative, the position was short, and the profit is the number of options times the premium at which they were sold. The premium has been received.

In either case, the full premium has changed hands.

3.5.4 Exercise.

Finally, an option position can be closed through an exercise or assignment.

In order to calculate the net profit or loss on an option position which has been exercised or assigned (either via early exercise or by automatic exercise of in-the-money options at expiry), we must look at two different transactions: the exercise (or assignment) itself, and the resulting futures transaction.

3.5.4.1 Effect on the Option Position.

If an option is exercised, the position must have been long, and it is reduced by the number of options exercised. If it has been assigned, the position must have been short, and it is increased (ie taken from a negative number to one closer to zero) by the number of options assigned.

These changes in option positions are treated as purchases or sales, <u>at zero price/value</u>.

The effect of the option purchases or sales at zero value is the same as in 3.5.3 above. V_c in Equation (4) is zero and so the participant will show a cumulative mark-to-market profit or loss on his option position of

$$P\&L_{OPT} = CUM_m = - N \cdot V_0 \tag{5}$$

Again, he has paid (if N > 0, ie if his position was long and he was exercising), or received (if N < 0, ie if his position was short and he has been assigned) the full option premium.

3.5.4.2 Effect on the Futures Position.

An option $C_{U,E,t,k}$ is exercised or assigned into a position in its underlying futures contract, $C_{U,E}$. Therefore, where the transaction list $\{n_i, p_i\}$ of an option contains exercises or assignments, the transaction list of its underlying futures contract will contain corresponding transactions in the future.

A long call exercised gives a purchase of a future; a long put gives a sale of a future. A short call assigned gives a sale of a future; and a short put assigned gives a purchase of a future.

These rules are summarised in the following table, which shows the futures transaction for each combination of position and option type.

TABLE 1: Futures Transactions resulting from Option Exercises and Assignments

Option Position	Exercise /Assignment	Call	Put
Long, ie N > 0	Exercise	N Futures: ie buy	-N Futures: ie sell
Short, ie N < 0	Assignment	N Futures: ie sell	-N Futures: ie buy

The futures contract is entered into at the strike price of the option, and will be marked-

to-market to the future's mark-to-market price at the end of the day.

Let the mark-to-market value of the future be F_m , and its value at the option's strike price be $V(k)$. Then the profit or loss on the futures transaction, $P\&L_{FUT}$ is found from the second term of the MtM Formula (assuming without loss of generality that there was no prior position in the future):

> If the exercise/assignment is of N calls, then, from Table 1, the futures transaction is of N futures contracts, and:

$$P\&L_{FUT} = N. \, (\, F_m - V(k) \,) \qquad\qquad \text{[Call]}$$

> If the exercise/assignment is of N puts, then, from Table 1, the futures transaction is of -N futures contracts, and:

$$P\&L_{FUT} = - \, N \, . \, (\, F_m - V(k) \,) \qquad\qquad \text{[Put]}$$

These two equations can be simplified by defining the intrinsic value at exercise, IV_t , of the option $C_{u,e,t,k}$ as:

$$IV_t = F_m - V(k) \qquad\qquad \text{if t = call}$$

$$IV_t = V(k) - F_m \qquad\qquad \text{if t = put.}[1]$$

This gives the gross profit or loss on exercise, ie on the resulting futures transaction, as the intrinsic value times the position:

$$P\&L_{FUT} = N \, . \, IV_t \qquad\qquad (6)$$

3.5.4.3 Combined Effect.

To find the net profit or loss on the whole option purchase/sale - exercise transaction, we must add the payment or receipt of the premium from Equation (5) to the profit or loss of Equation (6), to get:

$$P\&L = P\&L_{OPT} + P\&L_{FUT}$$

ie, $\qquad\qquad P\&L = - \, N \, . \, V_0 + N \, . \, IV_t$

This Equation makes it apparent that the holder has paid (N > 0) or received (N < 0) the premium; and has gained (N > 0) or lost (N < 0) the option's intrinsic value at the time of exercise.

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[1] Note that these definitions allow of a negative intrinsic value. In general an option will only be exercised if its intrinsic value is positive. However, it is possible that an option exercised during the day is found, when its futures mark-to-market price is fixed at the end of the day, to have been exercised non-optimally. The treatment is completely general and allows for these cases.

SECTION 4: MARGINING

4.1   Overview.

Margining is a hierarchical process, looking first at individual contracts, then at Classes of contracts, then at groups of Classes (Class Spread Groups) and finally at groups of Series (Series Spread Groups).

Figure 2 below, which illustrates a part of the hierarchy, is useful for locating which level in the hierarchy is being discussed and putting it in its context. The overview of the process which follows makes reference to the levels of the hierarchy and to the detailed treatment in Sections 4.2 to 4.9 below.

Figure 2: Margining Hierarchy

Price and Volatility Scenarios					

Level 1: Contracts

Future	Option	Option...	Future	Option...	Future...
CSE	CSE	CSE	CSE	CSE	CSE
Posn	Posn	Posn	Posn	Posn	Posn

Level 2: Classes

Near*	Middle*..	Near....
NRE ⟹ CDM	NRE ⟹ CDM	NRE ⟹ CDM
or CSM	or CSM	or CSM

Level 3: Series & Class Spreads Groups

INDI¶	ALSI¶....
NRE ⟹ SDM	NRE ⟹ SDM
or SSM	or SSM

Level 4: Series Spreads Groups

Index Contracts....
NRE ⟹ GDM
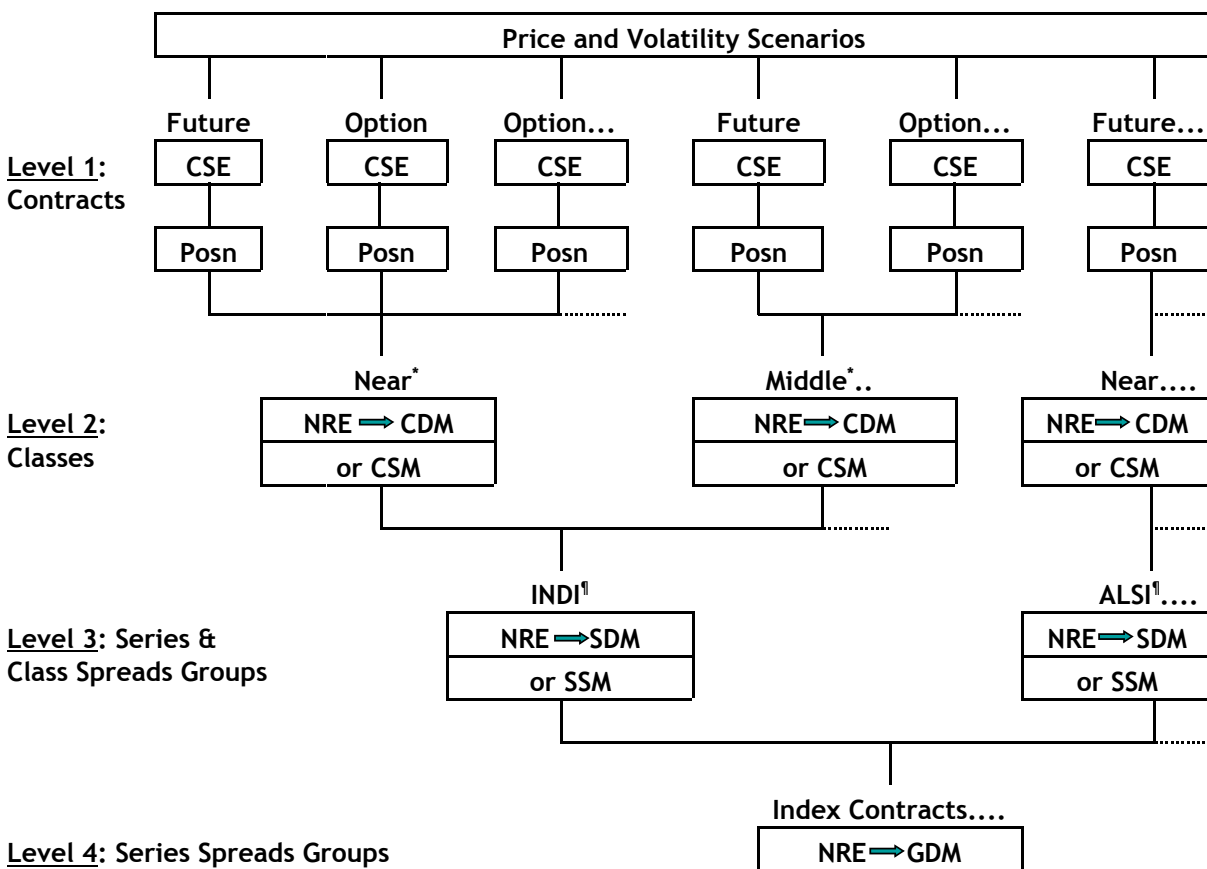
Legend: CSE = Contract Scenario Exposure   NRE = Net Residual Exposure
CDM = Class Direct Margin   CSM = Class Spread Margin
SDM = Series Direct Margin   SSM = Series Spread Margin
GDM = Group Direct Margin   Posn = Position
¶ = Members of the Index Contracts   * = Members of the INDI
Series Spread Group   Class Spread Group

4.1.1 Margining Levels.

The first level consists of futures contracts and options on them. Margins are not calculated separately on futures and options. A position in a future and options on it is consolidated to give a single position in the relevant Class. This is a position at Level 2.

Positions at Levels 2, 3, and 4 are represented by Net Residual Exposures or NREs. An NRE is a list of numbers, giving the profit or loss that the position would suffer under each of a number of pre-defined scenarios. These scenarios are assumptions about price and volatility changes which could occur by the next mark-to-market date.

The difference between positions at the last three levels is their degree of consolidation. Positions at Level 2 are Class positions, consolidating single futures contracts and options on them. Positions at Level 3 consolidate a number of Level 2 Class positions, to form a position in a Series. Finally, these Level 3 Series positions can be consolidated to give Level 4 positions.

The consolidation is achieved by adding together the NREs of the positions being consolidated. This process is called offsetting, because a loss at a particular scenario in one position can be offset by a profit at the same scenario in another position.

The consolidation at Levels 3 and 4 is completed by deducting, from the aggregate profit or loss at each scenario, a fixed amount equal to the sum of the Spread Margins of the positions being consolidated. These spread margins allow for the fact that the offsetting process may not be perfect in reality. The implicit assumption, that the price and volatility changes of the different component positions are perfectly correlated, may not be true.

RMCO will decide, by defining Class and Series Spread Groups, which Classes and Series are eligible for offsetting. If a position at a particular level (2, 3, or 4) is not eligible for further offsetting, it has a Direct Margin. This is equal to the maximum of all the losses of its NRE.

If it is eligible, its NRE, together with those of the other positions at the same level with which it is being consolidated, will enter the consolidation process to give an NRE at the next level down. In doing so, Spread Margins will be calculated for each of the positions being consolidated.

Hence there are two possible types of margin at Levels 2 and 3. If a position at one of these levels is ineligible for further offsetting, the minimum value of its NRE gives a Direct Margin. If on the other hand it is consolidated to the next level down, it will have a Spread Margin which is calculated during the process of consolidation. These Spread Margins form part of the new NRE of the combined positions.

4.1.2 Scenarios.

The first step is to construct the price and volatility scenarios. These are lists of possible future prices or volatilities, which are derived from Margin Requirements laid down by RMCO. (see Section 4.2)

4.1.3 Contract Scenario Exposures. (Level 1)

Each contract is then valued at each scenario, to get a list of Scenario Values (see Sections 4.3.1 and 4.3.2)

The latest mark-to-market value of the contract is then subtracted from each Scenario Value,

to get a list of Contract Scenario Exposures ("CSEs") (see Section 4.3.3). CSEs express the mark-to-market profit or loss, in Rands, which the contract would suffer under each scenario at the next mark-to-market date. [1]

CSEs correspond to the SPAN "risk arrays".

At this stage, it would be possible to margin each future and each option individually. However, the methodology assumes an automatic and full offset of positions in a future and options defined on it, ie at Level 1. Positions in these are aggregated - simply and directly, with no provision for spreads - into Class positions at Level 2.

4.1.4 Class Net Residual Exposures. (Level 2)

The treatment so far has been position independent. At this stage, it is necessary to bring in positions. The remainder of the process deals with the positions of a participant. [2]

Each position of the participant in each contract in each Class is multiplied by the relevant CSE, and the results summed to give the Class's Net Residual Exposure ("NRE"). (see Section 4.4). A Class's NRE expresses, in Rands, the profit or loss which the participant would suffer, under each scenario, in respect of his total position in that Class.

4.1.5 Class Direct Margins. (Level 2)

If a Class is not a member of a Class Spread Group, it has a Class Direct Margin. This is merely the maximum loss given by its NRE. (see Section 4.5).

Note that the scenarios are constructed in such a way that the margin on a straight, one single contract long or short, futures position will be equal to the Initial Margin Requirement.

If the Class does belong to a Class Spread Group, it has a Class Spread Margin, described below.

4.1.6 NRE of a Class Spread Group. (Level 3)

The first step is to combine the NREs of the eligible Classes to give a Provisional Residual Exposure or PRE for the spread group. (see Section 4.6.1). This is the participant's profit or loss under each scenario in respect of his combined positions over all eligible Classes - assuming that their prices move strictly in step.

To allow for the fact that prices of different Classes are not perfectly correlated, a Class Spread Margin will be found for each Class. The Class Spread Margin of a Class is equal to its Class Spread Margin Requirement (CSMR), multiplied by its Delta, multiplied by its Offset Proportion.

A Class Spread Margin Requirement is determined by RMCO for each Class in a Class Spread Group. It is a Rand amount, expressing the loss which could arise from the failure of the price

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[1] Note the use of the word "exposure" to mean a possible change in value, rather than the alternative usage sometimes found, to mean a gross position in a single instrument which behaves like the position under consideration.

[2] Note that the actual positions, $N_{u,e,t,k}$, are used to calculate the Net Residual Exposure, but then play no further part in the calculations. The positions are thereafter represented by their NREs.

of (one Delta's worth of) contracts in each Class to move perfectly in step with the prices of the other Classes in the Group. It will generally be small compared to the corresponding Initial Margin Requirement.

The <u>Delta</u> is a measure of how many straight futures contracts the Class position behaves like. A Class position does not have a single delta - in general its delta will be different at each scenario. Therefore it is necessary to define a "representative" Delta for the Class position. The method proposed is to let the Delta estimate be the maximum over all scenarios. (see Section 4.6.3).

The <u>Offset Proportion</u> gives the proportion of the Class's Deltas which have benefited from or contributed to offset. Again, this number varies across scenarios. The worst scenario is selected as the one where Offset Proportions are determined. (see Section 4.6.2)

> The contribution of each Class to the worst-case PRE is compared to its own minimum NRE before offsetting. This is in effect a "before" and "after" comparison, where the "before" is the margin with no offsetting, and the "after" is the contribution of the position to the margin after offsetting.

> If the comparison shows an improvement, the Class is said to <u>benefit</u> from the offsetting process. If it does not, the Class is said to have <u>slack</u>.

> The proportion of total benefit to total slack is found. This Offset Proportion is deemed to be the proportion of a slack Class's position which has contributed positively to the offsetting process and therefore is liable for a spread margin.

> The remainder of the Class's position is not spread margined, but does of course have its effect on the group's PRE.

> Classes which show a benefit are fully spread margined - their Offset Proportion is 1.0.

Finally, all the Class Spread Margins are subtracted from the Provisional Residual Exposure, to give the group's NRE (see Section 4.6.5).

4.1.7 Series Direct Margins. (Level 3).

The Class Spread Group's NRE appears as a Series NRE at Level 3.

If the Series is not a member of a Series Spread Group, it has a Series Direct Margin. This is equal to the maximum loss given by its NRE. (see Section 4.7).

If it is a member of a Series Spread Group, it will contribute to the NRE of the Series Spread Group at Level 4.

4.1.8 The NRE of a Series Spread Group. (Level 4).

Series Spread Margins are calculated in the same way as Class Spread Margins.

First the combined PRE of all the eligible Series is found (see Section 4.8.1). This belongs to Level 4.

Each Series in a Series Spread Group has its own Series Spread Margin Requirement, which is multiplied by its Delta and Offset Proportion to give its Series Spread Margin (see Section 4.8.4).

The Delta and Offset Proportion are found as for Class Spread Margins with only slight adjustments to be made to the calculation of the Delta.

The Series Spread Margins are subtracted from the group's PRE to give its NRE (see Section 4.8.5).

4.1.9   Group Direct Margins. (Level 4).

The NRE of a Series Spread Group, as calculated at Level 3, gives a Group NRE at Level 4. Since no further offsets are possible, the process terminates with the Group Direct Margin being the maximum loss over all scenarios in the Group NRE.

The remainder of Section 4 describes the margining process in detail.

4.2 <u>Scenarios</u>.

Scenarios are constructed from the relevant Margin Requirements and Scenario Sets. Both are determined by RMCO, but the former are subject to change on a daily basis, while the latter are fixed.

4.2.1 **Price Scenario Set.**

The <u>Price Scenario Set</u>, PSS, is a set of numbers

$$PSS = \{x\}$$

which are factors to be applied to Initial Margin Requirements to determine the price scenarios at which contracts in the Class are evaluated.

RMCO has determined the Price Scenario Set as:

$$PSS = \{ -1,-.75,-.5,-.25,0,.25,.5,.75,1 \},$$

so that contracts are valued at 9 price scenarios, corresponding to a range from -100% to +100% of their Initial Margin Requirements, in steps of 25%.

4.2.2 **Volatility Scenario Set.**

The <u>Volatility Scenario Set</u>, VSS, is a set of numbers

$$VSS = \{y\}$$

which are factors to be applied to a Volatility Scanning Range to determine the volatility scenarios under which options in the Series will be evaluated.

For example, if a Volatility Scanning Range is 2%, and the Volatility Scenario Set were given by:

$$VSS = \{-1, -.5, 0, .5, 1\}$$

then the volatility scenarios would be:

> volatility down 2%
> volatility down 1%
> volatility unchanged
> volatility up 1%
> volatility up 2%

RMCO has determined the Volatility Scenario Set as

$$VSS = \{1, -1\}.$$

This means that options are valued firstly with volatility up by their VSR and then with volatility down by their VSR. For obvious reasons, these two sets of scenarios are referred to as "Volatility Up" and "Volatility Down".

4.2.3 Scenarios.

A <u>Scenario</u> is a combination of a price and a volatility scenario:

$$[x,y] , \quad \text{with } x \, \varepsilon \, PSS \text{ and } y \, \varepsilon \, VSS$$

A value of a contract or position, calculated at a particular scenario [x,y], is referred to as a Scenario Value:

$$SV\,[x,y]$$

Futures Scenario Values (Section 4.3.1 below) are functions of price scenarios only; however, for generality of mathematical treatment, the notation SV [x,y] is used to refer to the Futures Scenario Value SV [x], with it being understood that the value is independent of y.

4.2.4 Volatility Scenarios.

All options in a Class C_{UE} are valued at the same volatility scenarios [1]. These are constructed around the market volatility of (near-the-money) options in the Class, known as the Option Margining Volatility.

Let the following be defined on C_{UE}:

OMV_{UE} the Option Margining Volatility [2]

and the following be defined on C_{UE}'s parent Series, S_U:

VSR_U the Volatility Scanning Range, ie the size of the range of volatilities to be scanned.

We also need two further parameters:

S   the Risk Parameter set by RMCO. This is the same for all expiries on all underlyings. Its value has always been 3.5, though it is subject to review by RMCO;

N_E an RPVE [3] Category which depends on the time to expiry of a contract, and is defined as described below.

Then the Volatility Scenario for options in C_{UE} is given by:

$$\sigma_{U,E}[x,y] = OMV_{U,E} \cdot \sqrt{\frac{[S \cdot x]^2}{N_E + 1} + \frac{N_E - 1}{N_E}} + y \cdot VSR_U \qquad (7)$$

N_E expresses the average remaining life, in days, of a contract, under the assumption (which is present for historical reasons) that contracts in a Series expire in a quarterly cycle. The intention is that all "Near" contracts should have $N_E = 45$; all "Middle" contracts should have $N_E = 135$, and so on. This state is not always precisely achievable, especially where Can Do options, for example, may have no clearly defined quarterly expiry cycle. In order to accommodate such contracts, without unnecessarily complicating matters, some compromises may sometimes appear in the above ideal scheme.

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[1]   Hence no explicit allowance is made for the "volatility smile", whereby away-from-the-money options have greater volatilities. Some recognition is accorded to the phenomenon, however, via the construction of volatilities in Equation (7).

[2]   Note that the Option Margining Volatility of a Class is the same as its mark-to-market volatility.

[3]   "RPVE" stands for "Range Price Volatility Effect". Before the RPVE Amendment was made in 1995, the recognition of the effect which a large price change (ie over the whole range implied by a contract's Initial Margin Requirement) would have on volatilities, was made in a blunter way.

N_E is found by reference to Q_E, which expresses (with the same sort of latitude) the number of expiry dates in the same quarterly cycle falling before a contract's own expiry date.

Values of Q_E are updated on a single defined day each month. This day is called the "RPVE day", and is defined as the first business day on or before the third Thursday of the calendar month. (Hence, in months in which Equity Index futures expire, the RPVE day will coincide with their expiry date).

On each RPVE day, the value of Q_E is updated for all contracts expiring at any time in any calendar month which is a whole multiple of three months away from the calendar month in which the RPVE day falls. (So, if the RPVE day is in July, Q_E is updated for all contracts expiring in the next October, January, April, and so on.) All contracts expiring in the calendar month which is 3n months from the current month (for n=1,2,3,...) will have their Q_Es adjusted from the value n (which will be their value before the margining calculations are performed for that night) to n-1. Contracts expiring in the month of the RPVE day will have Q_E = 0, and will not be adjusted.

Any new contract being listed will get the same value of Q_E as all other contracts expiring in the same calendar month, as on the day of listing. If there are none such (or, indeed, as a general process which will always work), count the calendar months from the present month (which shall be month zero) to the month of the contract's expiry date (which shall be month m). Then, if the expiry date is in the current month (m=0), put Q_E = 0. Else, if the listing date and time is before the process of updating Q_Es for the current month (ie before the night run on the RPVE day), put Q_E = Int(m/3). Else put Q_E = Int((m-1)/3).

Given Q_E, N_E follows by the formula:

$$N_E = 90 \cdot Q_E + 45$$

4.3.1 Futures Scenario Values.

4.3.1.1 Futures Contract can have Positive Values only

Let $C = C_{U,E}$ be a futures contract, with present mark-to-market price and value $V_{U,E}$ ($P_{U,E}$) where $V_{U,E} > 0$ (it can be any positive Real number only).

Let $IMR_{U,E}$ be the Initial Margin Requirement of C.

Then the Scenario Value of C at $x \in$ PSS and for any $y \in$ VSS is

$$SV_{U,E}[x,y] = Max(SV_{U,E}[x] = V_{U,E} + x.IMR_{U,E}, 0) \tag{8}$$

4.3.1.2 Futures Contract can trade at a Zero or Negative Value

Let $C = C_{U,E}$ be a futures contract, with present mark-to-market price and value $V_{U,E}$ ($P_{U,E}$) where $V_{U,E} \in \Re$ with $\Re$ the set of Real numbers.

     $IMR_{U,E}$ be the Initial Margin Requirement of C.

Then the Scenario Value of C at $x \in$ PSS and for any $y \in$ VSS is

$$SV_{U,E}[x,y] = SV_{U,E} + x.IMR_{U,E} \tag{8a}$$

4.3.2 Option Scenario Values.

Let $C = C_{U,E,t,k}$ be an option in the Class $CL_{U,E}$

     $SV_{U,E}[x]$ be a Scenario Value of its underlying futures contract, as defined in 4.3.1.

     T   be the date of the next mark-to-market.

     $V_{U,E}(k)$ be the value of C's underlying futures contract at its strike price.

     $\sigma_{U,E}[x,y]$ be a Volatility Scenario as defined in 4.2.4.

Then the Scenario Value of C at Scenario [x,y] is:

$$SV_{U,E,t,k} [x,y] = BLK [SV_{U,E} [x], V_{U,E}(k), \sigma_{U,E}[x,y], e-T, t] \tag{9}$$

4.3.3 Option Mark-to-Market Values.

The daily mark-to-market values of options can either be read off one of the daily data files (see Appendix B), or can be calculated. If calculated:

Let $C=C_{u,e,t,k}$ be an option contract.

$P_{u,e}$	be the mark-to-market price of C's underlying futures contract.
$V_{u,e}$	be the value of C's underlying futures contract at its mark-to-market price; ie $V_{u,e}=V_{u,e}(P_{u,e})$.
T'	be the date of the <u>current</u> mark-to-market.
$V_{U,E}$ (k)	be the value of C's underlying futures contract at its strike price.
$OMV_{u,e}$	be the Option Margining Volatility (ie, the mark-to-market volatility) for options on the underlying futures contract.

Then the mark-to-market value of C is:

$$V_{u,e,t,k} [x,y] = BLK [V_{u,e} [x], V_{u,e}(k), OMV_{u,e}, e-T', t] \tag{9a}$$

4.3.4 Contract Scenario Exposures.

The Contract Scenario Exposures of a contract are merely the differences between its Scenario Values and its present mark-to-market value:

$$CSE_{u,e,t,k} [x,y] = SV_{u,e,t,k} [x,y] - V_{u,e,t,k} \tag{10}$$

where $V_{u,e,t,k}$ is the contract's present mark-to-market value.

4.4 Net Residual Exposure of a Class.

Let the Class be $CL_{U,E}$ and the Contract Scenario Exposures of the contracts in the Class be $CSE_{U,E,t,k} [x,y]$.

Let the participant's position in each contract in the Class be $N_{U,E,t,k}$.

Then the Net Residual Exposure of the Class is:

$$NRE_{U,E}[x, y] = \sum_{t,k} N_{U,E,t,k} \cdot CSE_{U,E,t,k}[x, y] \tag{11}$$

where t and k range over all valid contracts in the Class, including its futures contract.

4.5 Class Direct Margins.

If the Class is not eligible for Inter-Class Spreads, it is now possible to find its Class Direct Margin. This is equal to the maximum of the losses it could suffer over all scenarios:

$$CDM_{U,E} = -MIN (NRE_{U,E} [x,y])\qquad(12)$$

where x ε PSS and y ε VSS range over all scenarios.

4.6 NRE of a Class Spread Group.

Assume now that the Class $CL_{U,e}$ belongs to a Class Spread Group, U = {$CL_{U,e1}$, $CL_{U,e2}$, ... }.

It is then necessary to find the PRE, or Provisional Residual Exposure, of the group; a Spread Margin for each Class within it; and finally its NRE which combines the PRE and the Spread Margins.

4.6.1 PRE of a Class Spread Group.

The PRE is the sum of the NREs of the Classes in U:

$$PRE_U[x,y] = \sum_{CL_{U,e} \in U} NRE_{U,e}[x,y]\qquad(13)$$

for all x ε PSS and y ε VSS.

4.6.2 Offset Proportion of a Class Spread Group.

4.6.2.1 Minimum Value Scenario.

It will be necessary to have information regarding the composition of PRE_U [x,y] at the scenario where it has minimum value.

Therefore, find the minimum value scenario [X,Y], ie let X and Y be such that [1]:

$$PRE_U[X,Y] = \underset{\substack{x \in PSS \\ y \in VSS}}{Min}[PRE_U[x,y]]$$

4.6.2.2 Before.

The margin of a Class before it participates in offsetting is:

$$B_{U,e} = -MIN (NRE_{U,e} [x,y])$$

ie, it is the same as $CDM_{U,E}$ as defined in Equation (12) in Section 4.5.

The sum of $B_{U,e}$ over all e's in the Class Spread Group is B_U.

4.6.2.3 After.

The corresponding figure after a Class has enjoyed offset is:

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[1] There is the possibility of a non-unique minimum. Ties are broken by taking the first occurence of a non-unique minimum, where the search order is:
   Volatility Up
      Price from lowest through to highest
   Volatility Down
      Price from lowest through to highest.

$$A_{U,e} = -NRE_{U,e} [X,Y]$$

4.6.2.4 Benefit.

The benefit of offsetting for a Class is:

$$BEN_{U,e} = B_{U,e} - A_{U,e}$$

The sum of $BEN_{U,e}$ over all e's is BEN_U.

4.6.2.5 Slack.

If a Class shows no benefit, it has potential slack - ie a portion of its position which does not contribute to the offsetting process and therefore should not be spread-margined. A non-benefiting Class's potential slack is the whole amount $A_{U,e}$:

$$PSL_{U,e} = A_{U,e} \qquad\qquad \text{if } BEN_{U,e} = 0;$$
$$= 0 \qquad\qquad\qquad \text{otherwise.}$$

The sum of the $PSL_{U,e}$'s is PSL_U.

It is deemed that the actual part of the total potential slack which is required for offsetting is no greater than the total benefits gained thereby:

$$ASL_U = MIN [BEN_U , PSL_U]$$

4.6.2.6 Offset Proportion.

The actual part required for offsetting is then pro-rated over the Classes which contributed to it; where the proportionate factor is:

$$Q_U = ASL_U / PSL_U \qquad\qquad \text{if } PSL_U \quad 0$$
$$= 1 \qquad\qquad\qquad \text{if } PSL_U = 0$$

This factor is allocated to Classes which have slack; the rest get a factor of 1.0, so that they are fully spread-margined:

$$Q_{U,e} = Q_U \qquad\qquad \text{if } PSL_{U,e} > 0; \qquad (14)$$
$$= 1 \qquad\qquad\qquad \text{otherwise.}$$

4.6.3 Delta of a Class Position.

The Class $CL_{U,e}$ has defined on it a Class Spread Margin Requirement $CSMR_{U,e}$. This represents the Rand spread margin for a simple position of one futures contract $C_{U,e}$. The actual position, represented by $NRE_{U,e}$, is likely to be a composite of futures and options positions.

We therefore need an estimate of the number of straight futures contracts that the composite position behaves like; in other words, a representative delta of the position.

Let PSS contain m elements, and be ordered as $\{x_i\}$, such that

$$x_{i+1} > x_i \text{ for all } i = 1 \text{ to } m-1.$$

Define the absolute delta of the Class position at the scenario $[x_i,y]$, i=1 to m-1, as:

$$\Delta_{U,e}[x_i, y] = \left| \frac{NRE_{U,e}[x_{i-1}, y] - NRE_{U,e}[x_i, y]}{(x_{i-1} - x_i) \cdot IMR_{U,e}} \right| \tag{15}$$

where $IMR_{U,e}$ is the Initial Margin Requirement of the contract $C_{U,e}$.

Then the Delta of the Class position is the maximum over all scenarios of all the absolute deltas:

$$\Delta_{U,e} = \underset{\substack{i = 1, m-1 \\ y \in VSS}}{\mathbf{Max}}\left(\Delta_{U,e}[x_i, y]\right) \tag{16}$$

The value $\Delta_{U,e}$ as found in Equation (16) must then be rounded to 2 decimal places.

4.6.4 Class Spread Margin.

It is now possible to find the Spread Margin of each Class in the Class Spread Group:

$$CSM_{U,e} = \Delta_{U,e} \cdot CSMR_{U,e} \cdot Q_{U,e} \tag{17}$$

where $\Delta_{U,e}$ is from Equation (16), $Q_{U,e}$ is from Equation (14) and $CSMR_{U,e}$ is the Class's Spread Margin Requirement.

The value $CSM_{U,e}$ as found in Equation (17) must then be rounded to 0 decimal places.

4.6.5 Group NRE.

Finally, we can find the NRE of the Class Spread Group. First define an unadjusted NRE as the group's PRE less the sum of all Class Spread Margins:

$$NRE'_U[x, y] = PRE_U[x, y] - \sum_{CL_{U,e} \in U} CSM_{U,e} \tag{18}$$

To guard against the eventuality that total margins under offsetting are greater than if there were no offsetting, the actual NRE is the unadjusted NRE, adjusted upwards where necessary. Total margins before offsetting have been found above in Section 4.6.2.2 as B_U, so:

$$NRE_U[x,y] = MAX[NRE'_U[x,y], -B_u] \tag{19}$$

for all x ε PSS and y ε VSS.

4.7 Series Direct Margins.

The inputs to the next stage are the NREs of Class Spread Groups as found in Section 4.6.5.

A Class Spread Group, being a collection of Classes, may be thought of as a Series.

If this Series is not a member of a Series Spread Group, its direct margin is:

$$SDM_U = -\underset{\substack{x \in PSS \\ y \in VSS}}{Min}[NRE_U[x,y]] \qquad (20)$$

4.8 NRE of a Series Spread Group.

Now assume that the Series S_u belongs to a Series Spread Group, S = { S_{u1} , S_{u2}, ...}.

The calculation of the NRE of the Series Spread Group follows the procedure described in 4.6 above for Class Spread Groups.

The steps are repeated below (in Sections 4.8.1 to 4.8.5) for completeness: the only difference lies in calculating the Delta of each Series position in the Spread Group. The figure corresponding to $IMR_{U,e}$ in Equation (15), where the absolute deltas of Series positions are being calculated, is the smallest of the Initial Margin Requirements of the Classes in the Class Spread Group which comprise the Series position. [1]

4.8.1 PRE of a Series Spread Group.

The PRE is the sum of the NREs of the Series in the Group S:

$$PRE_S[x,y] = \sum_{S_u \in S} NRE_u[x,y] \qquad (21)$$

for all x ε PSS and y ε VSS.

4.8.2 Offset Proportion of a Series Spread Group.

4.8.2.1 Minimum Value Scenario.

It will be necessary to have information regarding the composition of PRE_S [x,y] at the scenario where it has minimum value.

Therefore, find the minimum value scenario [X,Y], ie let X and Y be such that [2]:

$$PRE_S[X,Y] = \underset{\substack{x \in PSS \\ y \in VSS}}{Min}[PRE_S[x,y]]$$

4.8.2.2 Before.

The margin of a Series before it participates in offsetting is:

$$B_u = -MIN (NRE_u [x,y])$$

---

[1]   Note that Version 2 also gives another difference: "the unadjusted NRE, as found in Section 4.6.5, must be used in Equation (14)". However, by the Safex Notice Number 280, dated 14 March 1994, the "adjusted NRE should be used and not the unadjusted figure". This remains the position: the adjusted NRE is used (and therefore the unadjusted NRE is redundant). However, the use of an unadjusted is more accurate, and may be instituted in future. In that case, the Exchange will give (at least) 60 days' notice of the impending change; and these specifications will themselves be changed.

[2]   See the footnote to Section 4.6.2.1 for the tie-breaking rule.

ie, it is the same as SDM_u as defined in Equation (20) in Section 4.7.

The sum of B_u over all u's in the Series Spread Group S is B_S.

4.8.2.3 After.

The corresponding figure after a Series has enjoyed offset is:

$$A_u = -NRE_u \, [X,Y]$$

4.8.2.4 Benefit.

The benefit of offsetting for a Series is:

$$BEN_u = B_u - A_u$$

The sum of BEN_u over all u's is BEN_S.

4.8.2.5 Slack.

If a Series shows no benefit, it has potential slack - ie a portion of its position which does not contribute to the offsetting process and therefore should not be spread-margined. A non-benefiting Series' potential slack is the whole amount A_u :

$$PSL_u = A_u \qquad \text{if } BEN_u = 0;$$
$$= 0 \qquad \text{otherwise.}$$

The sum of the PSL_u 's is PSL_S.

It is deemed that the actual part of the total potential slack which is required for offsetting is no greater than the total benefits gained thereby:

$$ASL_S = MIN \, [\, BEN_S \, , \, PSL_S \,]$$

4.8.2.6 Offset Proportion.

The actual part required for offsetting is then pro-rated over the Classes which contributed to it; where the proportionate factor is:

$$Q_S = ASL_S \, / \, PSL_S \qquad \text{if } PSL_U \quad 0$$
$$= 1 \qquad \text{if } PSL_U = 0$$

This factor is allocated to Series which have slack; the rest get a factor of 1.0, so that they will be fully spread-margined:

$$Q_u = Q_S \qquad \text{if } PSL_u > 0; \qquad (22)$$
$$= 1 \qquad \text{otherwise.}$$

4.8.3 Delta of a Series Position.

We need here the representative delta for each Series S_u in S. These Series positions are (generally) themselves made up of a number Classes; as only Classes have Initial Margin Requirements, we must choose one of these for use in Equation (24).

We therefore define IMR_u to be the smallest of the Initial Margin Requirements of the Classes $Cl_{u,e}$ in the Class Spread Group u, defined in 4.6 above, making up the Series position S_u:

$$IMR_u = \min_{CL_{u,e} \in u}\left[IMR_{u,e}\right] \tag{23}$$

As before, we let PSS contain m elements, and be ordered as $\{x_i\}$, such that

$$x_{i+1} > x_i \text{ for all } i = 1 \text{ to } m-1.$$

We can now define the absolute delta of the Series position at the scenario $[x_i,y]$, i=1 to m-1, as:

$$\Delta_u[x_i, y] = \left| \frac{NRE_u[x_{i-1}, y] - NRE_u[x_i, y]}{(X_{i-1} - x_i)IMR_u} \right| \tag{24}$$

where NRE_u is the adjusted NRE as found for the Series u in Equation (19) [1] and IMR_u is as found above .

Then the Delta of the Series position is the maximum over all scenarios of all the absolute deltas:

$$\Delta_u = \max_{\substack{i = 1, m-1 \\ y \in VSS}}\left(\Delta_u[x_i, y]\right) \tag{25}$$

The value Δ_u as found in Equation (25) must then be rounded to 2 decimal places.

4.8.4   Series Spread Margin.

It is now possible to find the Spread Margin of each Series in the Series Spread Group:

$$SSM_u = \Delta_u . SSMR_u . Q_u \tag{26}$$

where Δ_u is from Equation (25), Q_u is from Equation (22) and $SSMR_u$ is the Series' Spread Margin Requirement.

The value SSM_u as found in Equation (26) must then be rounded to 0 decimal places.

4.8.5   Group NRE.

Finally, we can find the NRE of the Series Spread Group. First define an unadjusted NRE as the group's PRE less the sum of all Series Spread Margins: [2]

$$NRE'_S[x, y] = PRE_S[x, y] - \sum_{S_u \in S} SSM_U \tag{27}$$

To guard against the eventuality that total margins under offsetting are greater than if there were no offsetting, the actual NRE is the unadjusted NRE, adjusted upwards where necessary. Total margins before offsetting have been found above in Section 4.8.2.2 as B_S, so:

---

[1]   Note that it is in Equation (24) that the adjusted NRE would be replaced by the unadjusted NRE' of equation (18) if the change mentioned in the footnote to Section 4.8 above were ever to be implemented.

[2]   The unadjusted NREs are not themselves required at this stage. They are left in as a convenient stage in the calculations and for consistency with the treatment in Section 4.6.

$$NRE_S [x,y] = MAX [NRE'_S [x,y] , -B_S] \hspace{2cm} (28)$$

for all x ε PSS and y ε VSS.

4.9   Group Direct Margin.

The input to Level 4 is a Series Spread Group NRE as found in Section 4.8.5. Since no further offsets are possible, the process terminates with a Group Direct Margin calculated as the minimum value (ie as the maximum loss) shown by this NRE:

$$SDM_S = -\underset{\substack{x \in PSS \\ y \in VSS}}{Min}\big[NRE_S[x,y]\big] \hspace{2cm} (29)$$

4.10   Exotic Options

The IMR of exotic options are calculated using the methodology as set out in section 4.3. However, instead   of using the Black & Scholes formula in equation (9a), ons uses the relevant formula for the exotic option, e.g. if the exotic Can-Do is a Barrier option, one uses the Barrier option formula.

Another aspect taken into account is the fact that exotic options can behave differently to changes in the volatility as compared to vanilla options. The general premise in section 4.3 is that the option value increases when volatility increases translating into a bigger risk on the option writer's side. However, a knock-out Barrier option, for instance, has the opposite dynamics. If the volatility increases, a knock-out option becomes cheaper translating into a smaller risk for the option writer. Such dynamics are taken into account.

APPENDIX A: THE BLACK OPTION PRICING FORMULA

The formula described below was proposed by Fischer Black in his 1976 paper "The pricing of commodity contracts", *Journal of Financial Economics,* Volume 3. It is a variation of the well-known Black-Scholes formula. The "modified" version for fully-margined options on futures is given. This has the virtue of not requiring a risk-free interest rate as an input.

A.   BLACK FORMULA

It is required to find the option value V,

$$V = BLK [F, K, \sigma', T', t]$$

where
F   is the value of one futures contract;
K   is the value of one futures contract at the option's strike price;
σ' is the volatility expressed as a percentage per annum;
T'   is the time to expiry in days;
t   is the type of option, either put or call.

1.   Normalise the units by putting:

$$T = T' / 365$$

$$\sigma = \sigma' / 100$$

2.   Calculate the basic call price, C', using Black's formula:

$$C' = MAX [F - K, 0] \qquad \text{if } T \quad 0$$

$$C' = F . N [d_1] - K . N [d_2] \qquad \text{otherwise} \qquad (1)$$

2.1   The values d_1 and d_2 in Equation (1) are:

$$d_1 = \frac{\ln\left(\dfrac{F}{K}\right) + \dfrac{\sigma^2 T}{2}}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

2.2   The function N [•] in Equation 1 is the Cumulative Normal Integral. N[d] is calculated by the following polynomial approximation:

Let   z = * d *

and then find:

$$N(z) = 1 - \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}} \left(b_1 k + b_2 k^2 + b_3 k^3 + b_4 k^4 + b_5 k^5 \right)$$

where: k = 1/(1 + a.z)

and   a = 0.2316419
b_1 = 0.31938153
b_2 = -0.356563782
b_3 = 1.781477937
b_4 = -1.821255978
b_5 = 1.330274429

Then: N[d] = N(z)   if d > 0;
= 0.5   if d = 0;
= 1 - N(z)   if d < 0.

3.   **Call and Put Values.**

If t=Call, V is the call value found above, adjusted so that it cannot be less than the option's intrinsic value:

V = MAX [C', F - K]

If t=Put, V is found from:

V = MAX [C' - F + K, K - F]

Finally, the value of V is rounded to the nearest whole number, with fractional values of .5 and above being rounded upwards.

APPENDIX C: VALUE FUNCTIONS

This Appendix gives the functions, introduced in Section 2.5, to be used to convert Prices of contracts into their corresponding Values.

1. **Contract Size**

   Appendix B describes, *inter alia*, the Daily Data File SEddmmyy.CSV which gives information specific to Series of contracts. One field in this file is named "Size"; it gives a number which determines the size of contracts in the Series, and is used as described below.

2. **Equity Index and Krugerrand Contracts**

   The Value Function for the ALSI, INDI, FNDI, GLDI and KRND contracts is:

   $$\text{Value} = \text{Size} * \text{Price} \qquad (1)$$

   Size, from the appropriate records of SEddmmyy.CSV, is in the case of all these Series, equal to 10.

3. **BBF3 Contract**

   The Value Function for BBF3 contracts is:

   $$\text{Value} = \text{Size} * [1 - Y/4] \qquad (2)$$

   where:

   - Size is the value 1,000,000 (indicating R1m face value) to be found in SEddmmyy.CSV

   - Y is the "Price" of the contract, which is quoted as a yield. Y is expressed as a percentage (eg 12.25%) and must be divided by 100 before use.

4. **Bond Contracts**

   The Value Function for the R150 and R153 contracts is based upon the Bond Pricing Formula originally introduced by the Gilt Clearing House of the Johannesburg Stock Exchange.

   The Bond Pricing Formula is described in Appendix D. It gives an All-in Price, AIP, for R100 nominal of a bond, B, trading at a yield, Y, for settlement on a settlement date, S:

   $$\text{AIP} = \text{AIP} [B,Y,S] \qquad (3)$$

   (a) Bond Details

   The following table gives the details of the R150 and R153 bonds required by the Bond Pricing Formula:

Bond	Maturity Date	Coupon	1st Coupon dd/mm	2nd Coupon dd/mm	1st Books Closed dd/mm	2nd Books Closed dd/mm
R150	28-Feb-2005	12	28/2	31/8	31/7	31/1
R153	31-Aug-2010	13	28/2	31/8	31/7	31/1

(b) Settlement Date

The settlement date for futures contracts on bonds is the "standard settlement date" of the bond market for deals conducted in the spot market on the expiry date of the contract.[1] Presently the convention for standard settlement date is "second Thursday after trade date"; however this is sometimes overridden (for example if either the Thursday or the following Friday is a public holiday); and there is the possibility of a change to a "t + 3" convention in the future.

Whatever convention is used, the resulting settlement date for each futures contract in the R150 and R153 Series is given in the field "SettDate" of the Daily Data File CLddmmyy.CSV. The appropriate date from this file is the value S in Equation (3) above.

(c) Rounding

The All-in price produced by Equation (3) is rounded according to the conventions of the Bond Pricing Formula: ie it is a price per R100 nominal, rounded to 5 decimal places.

This price must now be further rounded, to 4 decimal places. This is to ensure that the value of a single contract is a whole number of Rands.

(d) Nominal Size

The bond contracts are defined on R1m nominal of the underlying bond. Hence the (doubly rounded) All-in price must be divided by 100 and multiplied by 1,000,000 to give the contract value.

Hence the final version of the Value Function is:

$$\text{Value} = \text{Size} * \text{ROUND}(\text{AIP}[B,S,Y],4) / 100 \qquad (4)$$

where:

- Size is the value from SEddmmyy.CSV for the Series;

- B is the underlying bond, which is the same as the 4-character Series name;

- S is the settlement date for the Class, from the file CLddmmyy.CSV;

- Y is the yield of the futures contract, expressed as a percentage; and

- the ROUND function rounds according to normal convention (ie with values of .5 and above following the last decimal place being rounded up).

---

[1] Note that the settlement date for each contract is fixed throughout its life, and is independent of the trade date.

5. **Options**

   All options are quoted in whole Rands per option. Therefore the Value Function for options is the identity function:

$$\text{Value} = \text{Price} \hspace{4cm} (5)$$

6. **Rounding**

   All contract Values must be rounded, where necessary, to zero decimal places.

APPENDIX E: EXAMPLE

The example which follows shows all steps in calculating the margin for a position of 5 contracts on 17/02/97. The mark-to-market and margining information for that day was taken from the example set of Daily Data Files in Appendix B.

The format of the example is:

- The left-hand part of each page shows the position, and its aggregation into Classes, Series and the Series Spread group.

- The middle portion of each page shows various input information required (from the Daily Data Files) and some results.

- The right portion of each page shows:

  the set of scanning arrays, covering all price and volatility scenarios. First the price scenarios for "Volatility Up" are presented; then, below them, the price scenarios for "Volatility Down". However, the position block is not repeated alongside the Volatility Down block.

  the calculations relating to the Offset Proportions of Class and Series Spread Groups.

References in the example are to the Sections and Equations of the main text.

Generally, most numbers are unrounded, and only their first few significant digits are displayed. Rounding only occurs:

- in the rounding of futures and option contract values (to 0 decimal places, as specified in Appendices A and C);

- in the rounding of the deltas of Class and Series positions (to 2 decimal places; Equations (16) and (25));

- in the rounding of Class and Series Spread Margins (to 0 decimal places; Equations (17) and (26)).

Position **Inputs / Results** **Scanning Arrays / Offset Proportions**

4.2.4 Volatility Scenarios

Pos	Undl	Date: 17/02/97 Expiry	C/P	Strike	OMV	VSR	Q No	N	Volatilities Up: Equation (7)								
									-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
10	ALSI	MAR 97			19.250	1.500	0	45	22.971	21.941	21.172	20.696	20.535	20.696	21.172	21.941	22.971
-10	ALSI	MAR 97	C	6500	"	"	"	"	"	"	"	"	"	"	"	"	"
50	ALSI	JUN 97	P	6700	19.750	1.500	1	135	22.050	21.673	21.399	21.232	21.177	21.232	21.399	21.673	22.050
-10	INDI	MAR 97			20.000	1.250	0	45	23.558	22.487	21.689	21.194	21.027	21.194	21.689	22.487	23.558
-100	INDI	MAR 97	P	8000	"	"	"	"	"	"	"	"	"	"	"	"	"

Volatilities Down: Equation (7)								
-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
19.971	18.941	18.172	17.696	17.535	17.696	18.172	18.941	19.971
"	"	"	"	"	"	"	"	"
19.050	18.673	18.399	18.232	18.177	18.232	18.399	18.673	19.050
21.058	19.987	19.189	18.694	18.527	18.694	19.189	19.987	21.058
"	"	"	"	"	"	"	"	"

4.3.1 Futures Scenario Values

Pos	Undl	Date: 17/02/97 Expiry	C/P	Strike	MtM Price	Contract Value	IMR	Futures Scenario Values: Equation (8)								
								-1.00	-0.75	-0.50	-0.25	0.00	0.25	0.50	0.75	1.00
10	ALSI	MAR 97			6483	64830	3500	61330	62205	63080	63955	64830	65705	66580	67455	68330
-10	ALSI	MAR 97	C	6500	"	"	"	"	"	"	"	"	"	"	"	"
50	ALSI	JUN 97	P	6700	6680	66800	3500	63300	64175	65050	65925	66800	67675	68550	69425	70300
-10	INDI	MAR 97			8078	80780	4500	76280	77405	78530	79655	80780	81905	83030	84155	85280
-100	INDI	MAR 97	P	8000	"	"	"	"	"	"	"	"	"	"	"	"

Position **Inputs / Results** **Scanning Arrays / Offset Proportions**

4.3.2 Option Scenario Values

Pos	Undl	Date: 17/02/97 Expiry	C/P	Strike	Strike Value	NextMtM 18/02/97 Days NextMtM to Expiry	-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
10	ALSI	MAR 97													
-10	ALSI	MAR 97	C	6500	65000	26	356	488	682	959	1336	1820	2405	3074	3808
50	ALSI	JUN 97	P	6700	67000	122	5484	4880	4324	3818	3367	2969	2625	2331	2084
-10	INDI	MAR 97													
-100	INDI	MAR 97	P	8000	80000	26	4356	3459	2658	1979	1436	1030	742	548	419

Option Scenario Values: Equation (9)								
-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
235	341	508	763	1129	1616	2216	2907	3663
5083	4457	3883	3364	2905	2506	2166	1881	1647
4205	3282	2459	1767	1226	835	571	401	296

4.3.3 Contract Scenario Exposures

Pos	Undl	Date: 17/02/97 Expiry	C/P	Strike	Futures MtMValue	Days to Expiry	Option MtMValue	-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
10	ALSI	MAR 97			64830			-3500	-2625	-1750	-875	0	875	1750	2625	3500
-10	ALSI	MAR 97	C	6500		27	1272	-916	-784	-590	-313	64	548	1133	1802	2536
50	ALSI	JUN 97	P	6700		123	3159	2325	1721	1165	659	208	-190	-534	-828	-1075
-10	INDI	MAR 97			80780			-4500	-3375	-2250	-1125	0	1125	2250	3375	4500
-100	INDI	MAR 97	P	8000		27	1382	2974	2077	1276	597	54	-352	-640	-834	-963

Contract Scenario Exposures: Equation (10)								
-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
-3500	-2625	-1750	-875	0	875	1750	2625	3500
-1037	-931	-764	-509	-143	344	944	1635	2391
1924	1298	724	205	-254	-653	-993	-1278	-1512
-4500	-3375	-2250	-1125	0	1125	2250	3375	4500
2823	1900	1077	385	-156	-547	-811	-981	-1086

Position **Inputs / Results** **Scanning Arrays / Offset Proportions**

Contract Residual Exposures

	Date:	17/02/97	C/						Contract Residual Exposures				
Pos	Undl	Expiry	P	Strike		-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
10	ALSI	MAR 97			[Contract Residual Exposures are	-35000	-26250	-17500	-8750	0	8750	17500	26250	35000
-10	ALSI	MAR 97	C	6500	not separately defined, forming part	9160	7840	5900	3130	-640	-5480	-11330	-18020	-25360
50	ALSI	JUN 97	P	6700	of the definition in Equation (11).	116250	86050	58250	32950	10400	-9500	-26700	-41400	-53750
-10	INDI	MAR 97			They are shown separately here for	45000	33750	22500	11250	0	-11250	-22500	-33750	-45000
-100	INDI	MAR 97	P	8000	ease of reading.]	-297400	-207700	-127600	-59700	-5400	35200	64000	83400	96300

					Contract Residual Exposures								
-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
---	---	---	---	---	---	---	---	---
-35000	-26250	-17500	-8750	0	8750	17500	26250	35000
10370	9310	7640	5090	1430	-3440	-9440	-16350	-23910
96200	64900	36200	10250	-12700	-32650	-49650	-63900	-75600
45000	33750	22500	11250	0	-11250	-22500	-33750	-45000
-282300	-190000	-107700	-38500	15600	54700	81100	98100	108600

4.4 Net Residual Exposure of a Class

Undl	Expiry	Class Spread	Net Residual Exposures: Equation (11)								
		Group	-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
ALSI	MAR 97	ALSI	-25840	-18410	-11600	-5620	-640	3270	6170	8230	9640
ALSI	JUN 97	ALSI	116250	86050	58250	32950	10400	-9500	-26700	-41400	-53750
INDI	MAR 97	INDI	-252400	-173950	-105100	-48450	-5400	23950	41500	49650	51300

Indicates minimum scenario
Class Direct Margin (4.5;
 Equation (12)):
or "Before" (4.6.2.2)

Net Residual Exposures: Equation (11)								
-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
-24630	-16940	-9860	-3660	1430	5310	8060	9900	11090
96200	64900	36200	10250	-12700	-32650	-49650	-63900	-75600
-237300	-156250	-85200	-27250	15600	43450	58600	64350	63600

Position   **Inputs / Results**   **Scanning Arrays / Offset Proportions**

4.6.3 Delta of a Class Position

Undl	Expiry	IMR	Deltas: Equation (15)							
			-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up
ALSI	MAR 97	3500	8.491	7.783	6.834	5.691	4.469	3.314	2.354	1.611
ALSI	JUN 97	3500	34.514	31.771	28.914	25.771	22.743	19.657	16.800	14.114
INDI	MAR 97	4500	69.733	61.200	50.356	38.267	26.089	15.600	7.244	1.467

[Deltas are shown out of sequence because they use the figures immediately above]

Max Delta Equation (16)	Deltas: Equation (15)							
	-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn
8.7900	8.789	8.091	7.086	5.817	4.434	3.143	2.103	1.360
35.7700	35.771	32.800	29.657	26.229	22.800	19.429	16.286	13.371
72.0400	72.044	63.156	51.511	38.089	24.756	13.467	5.111	0.667

4.6.1 PRE of a Class Spread Group

Undl	Class Spread Group PREs: Equation (13)								
	-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
ALSI	90410	67640	46650	27330	9760	-6230	-20530	-33170	-44110
INDI	-252400	-173950	-105100	-48450	-5400	23950	41500	49650	51300

Indicates Minimum Value Scenario (4.6.2.1)

Class Spread Group PREs: Equation (13)								
-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
71570	47960	26340	6590	-11270	-27340	-41590	-54000	-64510
-237300	-156250	-85200	-27250	15600	43450	58600	64350	63600

Position		Inputs / Results		Scanning Arrays / Offset Proportions

4.6.2 Offset Proportion of a Class Spread Group & 4.6.4 Class Spread Margin

		4.6.2.2	4.6.2.3	4.6.2.4	4.6.2.5		4.6.2.6 Eq (14)	4.6.3		4.6.4 Eq (17)
Undl	Expiry	Before	After	Benefit	Slack		Off. Pr	Delta	CSMR	CSM
ALSI	MAR 97	25840	-11090	36930	0		1.000	8.79	800	7032
ALSI	JUN 97	75600	75600	0	75600		0.488	35.77	900	15726
		101440	64510	36930	75600		Total Class Spread Margin:			22758

4.6.2.5	ASLu	36930
4.6.2.6	Qu	0.488

		4.6.2.2	4.6.2.3	4.6.2.4	4.6.2.5		4.6.2.6	4.6.3		4.6.4
INDI	MAR 97	252400	252400	0	252400		0	72.04	1200	0
		252400	252400	0	252400		Total Class Spread Margin:			0

4.6.2.5	ASLu	0
4.6.2.6	Qu	0

4.6.5 Group NRE: Unadjusted

		Unadjusted NRE: Equation (18)								
Undl		-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
ALSI		67652	44882	23892	4572	-12998	-28988	-43288	-55928	-66868
INDI		-252400	-173950	-105100	-48450	-5400	23950	41500	49650	51300

	Unadjusted NRE: Equation (18)								
	-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
	48812	25202	3582	-16168	-34028	-50098	-64348	-76758	-87268
	-237300	-156250	-85200	-27250	15600	43450	58600	64350	63600

Position	Inputs / Results	Scanning Arrays / Offset Proportions

4.6.5 Group NRE: Adjusted

Undl	-Margin before Offsetting	Adjusted NRE: Equation (19)								
		-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
ALSI	-101440	67652	44882	23892	4572	-12998	-28988	-43288	-55928	-66868
INDI	-252400	-252400	-173950	-105100	-48450	-5400	23950	41500	49650	51300

	Adjusted NRE: Equation (19)								
Indicates minimum scenario									
Series Direct Margin (4.7;	-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
Equation (20)):	48812	25202	3582	-16168	-34028	-50098	-64348	-76758	-87268
or "Before" (4.8.2.2)	-237300	-156250	-85200	-27250	15600	43450	58600	64350	63600

4.8.3 Delta of a Series Position

Undl	Min IMR	Series Deltas: Equation (24)								
		-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	
ALSI	3500	26.023	23.989	22.080	20.080	18.274	16.343	14.446	12.503	
INDI	4500	69.733	61.200	50.356	38.267	26.089	15.600	7.244	1.467	

[Deltas are shown out of sequence because they use the figures immediately above]	Max Delta Equation (16)	Series Deltas: Equation (24)								
		-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	
	26.9800	26.983	24.709	22.571	20.411	18.366	16.286	14.183	12.011	
	72.0400	72.044	63.156	51.511	38.089	24.756	13.467	5.111	0.667	

Position	Inputs / Results	Scanning Arrays / Offset Proportions

4.8.1 PRE of a Series Spread Group

	PRE of Series Spread Groups								
SSG	-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
ALFNDI	-184748	-129068	-81208	-43878	-18398	-5038	-1788	-6278	-15568

	PRE of Series Spread Groups								
Indicates Minimum Value	-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
Scenario (4.8.2.1)	-188488	-131048	-81618	-43418	-18428	-6648	-5748	-12408	-23668

4.8.2 Offset Proportion of a Series Spread Group & 4.8.4 Series Spread Margin

	4.8.2.2	4.8.2.3	4.8.2.4	4.8.2.5		4.8.2.6 Eq (22)	4.8.3		4.8.4 Eq (26)
Undl	Before	After	Benefit	Slack		Off. Pr	Delta	SSMR	SSM
ALSI	87268	-48812	136080	0		1	26.98	800	21584
INDI	252400	237300	15100	0		1	72.04	1000	72040
	339668	188488	151180	0		Total Series Spread Margin:			93624

4.8.2.5	ASLs	0
4.8.2.6	Qs	1

Position	Inputs / Results	Scanning Arrays / Offset Proportions

4.8.5   Group NRE: Unadjusted

		Unadjusted NRE: Equation (27)								
SSG		-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
ALFNDI		-278372	-222692	-174832	-137502	-112022	-98662	-95412	-99902	-109192

	Unadjusted NRE: Equation (27)								
	-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
	-282112	-224672	-175242	-137042	-112052	-100272	-99372	-106032	-117292

4.8.5   Group NRE: Unadjusted

	-Margin before Offsetting	Adjusted NRE: Equation (28)								
SSG		-1.00Up	-0.75Up	-0.50Up	-0.25Up	0.00Up	0.25Up	0.50Up	0.75Up	1.00Up
ALFNDI	-339668	-278372	-222692	-174832	-137502	-112022	-98662	-95412	-99902	-109192

	Indicates minimum scenario Group Direct Margin (4.9; Equation (29)):	Adjusted NRE: Equation (28)								
		-1.00Dn	-0.75Dn	-0.50Dn	-0.25Dn	0.00Dn	0.25Dn	0.50Dn	0.75Dn	1.00Dn
		-282112	-224672	-175242	-137042	-112052	-100272	-99372	-106032	-117292

Margin for the whole Position: R282,112