

PN - ABL-737

**A SYSTEM REVIEW OF THE  
COLOMBO STOCK EXCHANGE'S  
CENTRAL DEPOSITORY SYSTEM**

by Securities Industry Specialist

Bill Gorman  
5104 Los Feliz Blvd.  
Los Angeles CA 90027  
U.S.A.  
1-213-661-8050

June 22, 1992

1

**CSE's Central Depository System**

June 22, 1992

**A System Review of the Colombo Stock Exchange's****Central Depository System****Table of Contents**

i. Preface . . . . .	3
1. Executive Summary . . . . .	4
2. A Definition of the CDS System . . . . .	5
2.1 CDS as a Depository . . . . .	5
2.2 CDS Floor Support Procedures . . . . .	6
2.3 Off-floor Trade Processing . . . . .	7
2.4 Depository Procedures . . . . .	7
2.5 End of Day Processing . . . . .	8
2.6 CDS Computer Hardware and Software . . . . .	9
3. General Impressions . . . . .	10
3.1 Possible Single Points of Failure . . . . .	10
3.2 Absence of a Backup System . . . . .	13
3.3 Unknown Capacity and Performance . . . . .	15
3.4 System Security . . . . .	16
3.5 Issues of Privacy . . . . .	19
3.6 Remote System Access . . . . .	20
3.7 Comparing CDS with other Depository Systems . . . . .	21
3.8 Trade Reporting Issues . . . . .	25
3.9 Market Data Reporting . . . . .	26
3.10 Market-Making . . . . .	28
3.11 Immobilisation without Certificates . . . . .	28
3.12 Sri Lanka as a model . . . . .	29
3.13 Development Issues . . . . .	29
4. Participant Perspectives . . . . .	31
4.1 Brokers . . . . .	31
4.2 Custodian Banks . . . . .	32
4.3 Clearing Bank . . . . .	33
4.4 Registrars . . . . .	34
4.5 Institutional Investors . . . . .	35
4.6 Individual Investors . . . . .	36
4.7 Listed Companies . . . . .	37
4.8 Colombo Stock Exchange . . . . .	38
4.9 Securities and Exchange Commission (SEC) . . . . .	39
5. Terms of Reference . . . . .	41
5.1 Internal Control Functions . . . . .	41
5.2 Application Controls . . . . .	44
5.3 Security and Protection/Provisions . . . . .	46
5.4 Contingency Plans . . . . .	48
5.5 Information Systems Management Controls . . . . .	49
5.6 Top-Level Management Control . . . . .	51

**CSE's Central Depository System**

**June 22, 1992**

**i. Preface**

This document is a report on the status of the Colombo Stock Exchange's (CSE) Central Depository System (CDS). It contains the conclusions and recommendations reached during a comprehensive system review of the CDS system.

The acronym CDS has two meanings. The CSE subsidiary company, CDS is a securities depository. Its primary function is to hold stocks and bonds for safekeeping, on behalf of their owners. The CDS System is a computer system for the settlement of CSE equity trades and identification of the beneficial owners of the securities held by the depository. It achieves its efficiencies by immobilising share certificates and registering ownership changes through "book-entry".

No study of this magnitude could be the work of a single person. Accordingly, The author wishes to thank all those who assisted him. Participants from every part of the Sri Lanka equities market gave of their valuable time. Their numbers are too large to be individually enumerated. Especial thanks are extended to Quotron Systems, Inc. and their parent Citibank, NA for their help in funding part of this study.

This report and its recommendations are solely the responsibility of its author and do not necessarily reflect the views of those who assisted him.

CSE's Central Depository System

June 22, 1992

**1. Executive Summary**

The Colombo Stock Exchange's Central Depository System or CDS is a good, apparently robust system and an excellent platform for expansion of the Sri Lanka securities market. Few exchanges have accomplished as much with such modest expenditures. In fact only a small percentage of exchanges around the world have yet created a properly functioning depository system.

Notwithstanding these good marks, the CDS has a number of exposures which must be addressed. In addition, there are a number of opportunities for the exchange to profit from enhancements to the system. To address these exposures and take advantage of the opportunities, the following is recommended:

- \* A viable backup must be provided. This should include backup for individual devices (e.g. printer, disk drive, tape drive, etc.) and for the overall system.
- \* A mechanism for determining the system's capacity and performance should be developed. This should be used to ensure the CSE's ability to meet anticipated growth.
- \* The system's security and privacy features should be enhanced.
- \* Remote electronic access should be provided, as soon as practical, to all brokers. When possible this capability should be offered to the custodian bank community.
- \* The CSE should orient its future software development to meet international securities industry standards.
- \* The CDS system should be modified to accommodate real-time reporting of trades.
- \* The CSE should develop an electronic market data broadcast (a variety of ticker).
- \* CSE should resolve the issue of what computer architecture it shall use for future systems.

It is the authors opinion that exchanges (and depositories) are service organisations. They do not exist to provide profits to their owners (members). Instead their function is (should be) to provide a fair and orderly marketplace for securities trading. This should be for the benefit of all, not just exchange members. It is therefore recommended that the CSE carefully address the concerns of all market participants in deciding its future systems direction.

One of CSE's goals is to attract investment to Sri Lanka's equity markets. The quality of its CDS System should be a major plus in that effort. The CSE should therefore seek to communicate to the international investment community a general understanding of its market and how it functions.

**CSE's Central Depository System**

June 22, 1992

**2. A Definition of the CDS System**

The computer system known as the Central Depository System or CDS is a great deal more than just a depository system. Although trading is not automated, CDS performs vital trading support functions. The CDS computer system is logically divided into the following five functional sub-systems:

1. **Market Information** - captures and makes available at CDS terminals, price quotations (bids and offers) and other market data. It also calculates and provides statistical data such as the day's opening, high and low prices.
2. **Trade Processing** - captures details of trades executed and reports them via Contract Notes and other reports.
3. **Central Depository** - performs trade clearance, settlement and depository functions including maintenance of CDS ledger accounts and broker settlement accounts. It maintains the identity of the beneficial owner of all securities registered in the Depository's nominee name.
4. **Surveillance and Management Information** - maintains listed company information and other data for monitoring and controlling trading activity.
5. **Access Security and Control** - manages system security and restricts access to authorised users. It also controls what tasks each user may perform.

A major objective of the CDS system is to attract active participation in Sri Lanka's Equity Markets from domestic and overseas investors. One of the ways this is to be achieved is through more efficient and less troublesome trade settlement.

The CDS system is a terminal oriented on-line real-time system which integrates the trading functions of the exchange with the settlement and custody functions of the depository.

**2.1 CDS as a Depository**

The primary function of a securities depository is to immobilise or dematerialise securities. Immobilisation occurs when certificates representing ownership are held in a vault, usually by a depository in its nominee name, and ownership is transferred by "book entry" in the holder's books. Dematerialisation occurs when ownership is represented in the form of electronic records, in lieu of paper certificates.

In either case, the processing of transactions in "book entry" form is the basis for achieving efficient and low risk settlement of trades by transferring ownership from one account to another through simple debits and credits on the depository's books. CSE's Depository does not have a vault nor does it retain physical custody of certificates for more than one business day.

**CSE's Central Depository System**

**June 22, 1992**

The CDS employs a hybrid form of immobilisation. It deposits the certificates it receives with the Registrar or Company Secretary for those shares. No replacement certificates are issued. Instead the deposited shares are transferred (in the company's books) into CDS' name. As a result, the Registrar's books identify CDS as owner (custodian in reality) of those shares and CDS' books identify the beneficial owners.

**2.2 CDS Floor Support Procedures**

Trading on the Colombo Stock Exchange is by "open outcry". Quotes and trades are recorded on a Whiteboard at the front of the trading floor. The name of each security traded on the CSE is marked on the whiteboard with its symbol indicated by boxes around each letter in the symbol. Space is provided for entering the most recent trade price (and volume) plus current bids and/or offers (with the identity of up to two quoting brokers) for each security. These are entered on a Whiteboard on the trading floor by exchange employees known as Board-markers. As this information is written on the Whiteboard, an exchange employee then key-enters it into the system at a CDS floor terminal. The system makes those data immediately available to user terminals.

When a trade is agreed the buyer and seller together report it to a Trading Post Manager who records the trades details, in their presence, on a "pro forma transactions" sheet. Each sheet is identified by the Trading Post Managers initials and a sequence number (to ensure trades are reported in their proper order). Up to ten trades are recorded on these sheets which, upon completion (or after a certain elapsed time) are sent to the computer room for keying.

During the trading day, data processing personnel periodically print run sheets for each broker, identifying their trades. Using these sheets as a guide, the Brokers verify that the trades are correct and key enter at their floor terminals the identities of the buyers and sellers for each of their trades.

Trading is conducted from 9:30 am to 11:45 am with a break between 10:45 am and 11:00 am to provide brokers time for verifying trades executed. At the end of the trading day and after all trades have been entered into the system, final run sheets are printed and delivered to each broker (generally by 12:15 pm). The deadline for entry of client ids by the brokers is generally around 2:00 pm.

CSE rules prohibit short-selling (selling shares the seller does not own). Shares eligible for deposit in the CDS must be deposited in the CDS before they can be traded. In addition the identity of all buyers of CDS eligible shares must be provided on trade day. As a result, there are no market-makers in the Colombo equities market.

**CSE's Central Depository System****June 22, 1992****2.3 Off-floor Trade Processing**

A data processing department Control Clerk receives the trade sheets, assigns them a sequential batch number and gives them to a Data Entry Operator for keying. The CDS system performs validity checks on these transactions as they are entered. Rejects are returned to the floor for correction. After all trades on a sheet have been entered and accepted by the system, it is given to a second Operator who enters each transaction a second time as a verification procedure. As part of its Audit procedures, the system records the identity of the data entry operator (keyer) and the key-verifier.

During the trading day, the CDS system records all trades in a "Pro Forma Transactions" file. It is this file that must be updated with client ids. At around 2 pm, an exception report is generated identifying trades that lack this information.

**2.4 Depository Procedures**

Settlement of all trades in depository eligible issues is performed by the CDS system. Share movement is on Trade day or "T". The system debits the seller's account so that the securities cannot be sold twice. Money settlement is on T+7. Should something happen to prevent final settlement, the transaction can be cancelled.

Shares must be deposited with the CDS before they can be traded. Thus investors who wish to trade securities for which they hold certificates of ownership, deliver them to their broker who in turn deposits them with the CDS.

Certificates are deposited using a "Sold Transfer" form. Both the certificates and the forms are signed by the party(s) whose name(s) is on the certificate and by the delivering broker (using the broker's authorized signature and stamp). If the securities owner(s) does not have a CDS account through the depositing broker, an "Application for Opening of Securities Account" is also required.

The CDS processes these forms on the day they are received. They are visually checked for correctness and if deemed valid are key entered in the CDS system by a CDS employee. The system performs standard validity checks on the keyed data. One such check occurs when a depositor's identity is keyed. The system returns the depositor's name and asks the data entry operator to verify it against the name on the deposited certificate. Rejects are returned to the depositing broker for correction. Valid entries are time-stamped and logged into the system and a copy of the keyed forms is returned to the broker. The original forms are retained by the CDS.

After keying, the certificates are stored in an off-site vault. On the next business day they are sent to the appropriate Registrar or Company Secretary for transfer into CDS' name. They are accompanied by a CDS transfer form identifying the shares being transferred and noting CDS' share balance as of the completion of the transfer. By law the Registrar has 14 market days to effect the transfer.

The CDS maintains the identity of the beneficial owner(s) of the shares deposited with it. When a dividend or other corporate action is to be effected, a listing of the names and addresses of the owners and their share balances is provided to the Registrars for direct communication with those owners.

### **2.5 End of Day Processing**

A report listing the days trades and related statistics is printed at the end of each trading day. This is faxed to local newspaper offices. The deadline is 1 pm for the Sinhalese newspapers and 2 pm for the English papers.

At the end of the trading day, floor personnel advise computer operations when client ids have been entered for all trades. The CDS system operator queries the system to verify this, and if correct, starts end-of-day processing. The Pro Forma transactions are then promoted to the "Main Transactions" file. After the brokers have confirmed their agreement with the trades as recorded, the day's trading statistics are regenerated. After all activity ceases, a final posting run to update CDS' ledgers is performed.

Upon completion of End of Day (EOD) trade processing, the system prints "Contract Notes" for each trade. These are printed on special 3-part pre-printed "Sold Note" and "Bought Note" forms. These are provided to the brokers, who, under exchange rules must stamp, sign and mail the original, within twenty-four hours, to their clients as "Confirmations" of their trades. The two copies are retained for the brokers own use. Buy and Sell contracts (contracts between brokers) are also produced at this time.

Operations also prints a number of other reports at this time including a Daily Client Listing showing the holdings of every client as of the end of each trading day. This listing is printed twice, once in the evening and once in the am. The evening printout is given the floor brokers so that they may verify client holdings for the next days trading. The second copy is stored by the CDS as its end-of-day snapshot (paper record) of client holdings. It is printed in the morning before start of trading because of the time it takes to print (one and a half hours plus). This double printing occurs because it is cost-efficient to print the same report twice than to print once on more expensive two-part paper.

**CSE's Central Depository System**

June 22, 1992

**2.6 CDS Computer Hardware and Software**

The CDS system operates on a single Unisys A1-FX computer with 12 MegaBytes (MB) of main memory (or just over 12 million characters), a 560 MB disk drive and a 550 line per minute printer. The system currently supports a couple of dozen directly-connected terminals. Most of these are on the trading floor with the balance in the computer room and the CDS operations area.

The computer is configured for 12 communications lines and modems (modulator - demodulators which convert a computer's digital signal to a telephone line's analogue signal) for linking participant offices with the CDS system.

The system software includes: an A1-SP 4 System Software, an ERGO Extended Retrieval software tool and a LINC II Compiler. The system has been developed and is operated using these software tools. These tools enable programmers to write their applications in a higher-level language (simplifies the programming process by eliminating extraneous detail which can be better supplied by these tools). The tools generate standard COBOL 74 (a programming language) code which is then compiled into a functioning application.

The application software was written by BC Computers Ltd., Colombo Sri Lanka, a member of the Bartleet Group and an authorised Unisys vendor. It is this software which is the subject of this review.

**CSE's Central Depository System**

June 22, 1992

**3. General Impressions**

The Colombo Stock Exchange's Central Depository System or CDS is a good, apparently robust system and an excellent platform for the expansion of the Sri Lanka equity market. Few exchanges have accomplished as much with such modest expenditures. In fact only a small percentage of exchanges around the world have yet created a properly functioning depository system. Given the trade settlement difficulties that existed with CSE's previous manual procedure, it can be said the new system was sorely needed.

Notwithstanding these good marks, the CDS has a number of exposures which must be addressed. In addition, there are a number of opportunities for the exchange to profit from enhancements to the system. This section addresses the principal exposures and opportunities discovered during the course of this study.

**3.1 Possible Single Points of Failure**

There are several potential points at which the system could fail and leave the exchange unable to operate and/or in a seriously restricted mode. These include the printer, disk drive, tape drive, the computer's Central Processing Unit (CPU) and the Uninterruptible Power Supply or (UPS). Most of these exposures are the result of dependence upon electro-mechanical devices for which no backup currently exists. Repair service is available within a few hours but the closest spare parts depot for much of this equipment appears to be Singapore. As a result, repair could take days to effect. The principal exposures along with some alternatives are:

**\* Printer**

CDS depends upon a 650 line per minute printer for its daily operation. It is used to print contract notes and other reports, much of which is time critical and crucial to settlement. It is heavily used (often as much as 8 to 10 hours per day) and has failed during production in the past. That failure was addressed by writing the reports to tape and printing them using an off-site computer system. This was successful but is at best a clumsy and slow alternative.

The proper solution is to acquire a second printer. An excellent alternative would be to add a laser printer capable of printing 10 pages or more per minute. Faster laser printers are available but cost-benefit tradeoffs coupled with the ability to print two different reports at the same time might favor the use of two moderate speed printers over a single higher speed device.

CSE's Central Depository System

June 22, 1992

Many benefits would accrue from the addition of a second printer including:

- \* Reduced paper costs. Output would be printed on standard A4 sheet paper as opposed to the 11 X 14 continuous form paper now used.
- \* Easier report handling since bursting of continuously connected forms or paper would be rendered unnecessary.
- \* Reduced storage and handling costs for the CDS and its participants due to the smaller paper size used.
- \* Provision for more useful and more attractive output at lower cost through the creation of special forms and logos during the printing process. It should be noted that creating special graphics or forms on the laser printer can slow the printing process.

A laser printer would be inexpensive, consume little space and able to print most of the reports generated by CDS. It could be backed up by transferring the reports via file transfer software to local PCs for printing. This would enable the CDS to use PCs in its offices and equipped with laser printers as a low cost printer back-up system.

A caution is in order. The Contract Notes are printed on 3-part pre-printed forms and the Monthly Statements are printed on 2-part forms. Laser printers do not print multi-part forms. If these are to remain on multi-part pre-printed forms, it may be necessary to acquire a line (impact) printer as the backup device. The writer of this report believes that a redesign of these forms and their usage may be more efficient.

The Contract Notes are printed centrally by the CDS to enhance investor confidence in the depository process. The 3-part form must be decollated by the broker. The original is mailed (as a confirmation of the trade) to the client and the copies retained for internal use. The Monthly Statements take around 8 hours to print and is printed twice. To address the enormous print load, the CDS is considering printing statements for accounts having no activity, only on demand or quarterly/annually.

The first print run of the Monthly Statement is delivered to the broker on two-part paper. Again the intent is to mail the original to the client with the copy being retained for the broker's use. One alternative might be to print only the client copy and to provide the brokers their copies in computer readable form and/or microfiche.

The second print run of the monthly statement is retained by the depository as its permanent record or snapshot of the months activity and closing balances.

CSE's Central Depository System

June 22, 1992

Another large report is the Daily Client Listing which shows the holdings of every account (by broker) in the CDS. Preparing it takes 2 hours of computer time and another 1.5 hours to print. Its purpose is to provide brokers with a means of verifying that a client has the securities on deposit that the client wishes to trade. A second copy of this report is printed each day as a snapshot (permanent record of a day's status) for CDS files. This report poses a huge storage problem (a few boxes of paper each week and growing) and is a candidate for redesign especially after CDS provides participating brokers with remote access to its files. This report is further discussed in Section 3.5 Issues of Privacy.

Systems such as CDS generate enormous amounts of printed output which often seems to grow uncontrollably. Often this growth occurs because the links between a systems and its users is limited. Thus it would appear to be worthwhile to establish regular reviews of system output to verify their continued usefulness and that the reports are efficient and remain the best means of achieving their assigned function.

\* Disk Drive

The disk is probably the most serious immediate exposure. The system cannot run without it. It is also heavily loaded. It contains all of the files needed to run the system including application software (both production and test), current and historical data, test material, etc. It has a storage capacity of 560 Megabytes (MB) of which approximately 520 MB is used as follows:

System software .....	160 MB
Development software and tools .....	140 MB
Work space .....	60 MB
CDS application and database .....	<u>160 MB</u>
Total ..	520 MB

The disk's read/write arm undergoes a lot of flail in that it must continually flip between records and files that are widely dispersed across the disk. This is to be expected on a single disk system that is used to record activity on a transaction by transaction basis. The CDS system must read and write several disk records (for example, buying broker, selling broker, security master, audit logs, etc.) in order to process a single trade. This of course can have a dramatic effect on performance.

The solution to this exposure is to add one or more disk drives to the system. Properly configured this would also improve system performance. At present, since all files are on the same device and access to those files is serial, performance is directly affected by the number of disk

CSE's Central Depository System

June 22, 1992

records and files that must be processed to complete a transaction. By separating concurrently used files onto different disks, file contention can be reduced and system performance improved. In addition, the CDS files could be spread across the two disk in a way that allowed immediate recovery to either disk should the other fail.

\* Tape Drive

Ordinarily loss of a tape drive would not totally disable the system. It does however make it very difficult to perform backup and end-of-day functions.

The best course would be to have a backup tape drive. Alternatively if a second system is to be acquired as a total system backup, the backup system's tape drive could be used as an alternative to having two such drives on one system.

\* Uninterruptible Power Supply (UPS)

The CDS system is equipped with a UPS system whose function is to smooth out the jitter in the electrical power supply and to protect the equipment from power system failures. The UPS has battery power sufficient to operate the CDS system for a few minutes. This eliminates the problems that result from momentary power interruptions and provides sufficient time to perform either a switch-over to private generator power or an orderly shutdown in the event of a total power outage.

There is no backup for this device. Backing up only this device seems impractical and expensive. A second UPS should be included as part of a total systems backup proposed in the next section.

**3.2 Absence of a Backup System**

The Central Processing Units (CPU) that are the heart of today's computers are very reliable and generally operate for years without failing. Of course, when a CPU does fail, any system without backup is completely unable to function and may be worse than useless.

CDS has no in-house backup for its CPU. In the event of a failure that cannot be repaired within a day, CDS' contingency plan (unwritten) is to load the CDS system onto BC Computer Ltd's (the system's developers) in-house computer and to operate from it until the CDS computer is fully restored. BC Computers have an identical configuration to CDS'. This is a useful alternative for extreme emergencies but it is a difficult solution to effect and should not be considered an effective first level backup.

**CSE's Central Depository System**

June 22, 1992

CDS' architecture is such that only way to achieve full backup capabilities is to maintain redundant systems. The techniques most commonly employed in such cases are:

- \* Active monitor configuration - Under this method, the backup system continuously monitors and/or replicates the primary computer's activity. If the active system fails, the backup is supposed to assume its tasks. This is an older technology as well as costly and somewhat difficult to maintain. Its purpose is to provide for continuous operation system regardless of hardware failures. In general it has been superseded by fault-tolerant computer hardware and software systems.
- \* Hot standby - Under this scheme, the backup computer is kept in a continuously ready state with the application software loaded and ready to run upon operator command.
- \* Cold Standby - With this approach, the backup computer is used for other tasks. In the event of a failure these tasks are halted, and the backup is loaded with the CDS software, the data files are reloaded from the log files and the system restarted. This is the least expensive of these approaches in that it permits the use of the backup computer for other tasks.

The cold start backup is recommended for use with the CDS system. It maximises operational flexibility. The backup system could be used for multiple functions such as development, testing, logging of on-line system activity, off-line printing, communications front-end, etc. The total load may be such that when all essential functions are on a common CPU, the system runs in degraded mode but is clearly preferable to a total outage.

Operating the backup computer from the same facility as the primary system does not provide protection against site disasters such as fire or malicious mischief of a physical nature. Of course backing up the computer does not provide a backup for the trading floor, but with careful planning the effect of a site disaster can be minimised. The CSE may wish to locate its backup in a separate location from its primary operation. To achieve this off-site backup, special computer-to-computer lines and software must be implemented. Off-site backup increases operational complexity and is more difficult to manage but it also affords a higher level of protection.

When operating a two-site system, an especial challenge is maintaining a high level of training and preparedness of the operations staffs in both sites. It is generally advisable to operate useful functions from both sites and to regularly alternate those functions between sites. In that way the operators get to know all systems quite well. Regular exercises in disaster recovery and system switch-over should be conducted so as to ensure to the degree possible, staff preparedness.

It is an imperative that the development process be carefully

## CSE's Central Depository System

June 22, 1992

isolated from production. This is best done with two systems, one operating production and the other used for development. Regardless of how the backup system is to be used, software development cannot be allowed to interfere with production.

It has been estimated that it may be February 1993 before a backup system can be acquired for the CDS. It would therefore be prudent for the exchange to develop and test a Contingency Plan that employs BC Computers' Unisys computer as a backup.

### **3.3 Unknown Capacity and Performance**

The CDS system's precise limits are unknown. The Unisys computer's Operating System provides a tool for measuring CPU utilisation and number of Input and Output (I/O) events (interrupts in computer jargon) per second within its Menu Assisted Resource Control (MARC) system. It is inappropriate to use the statistics generated without detailed study. Nonetheless the system and its I/O has been recorded as heavily utilised during key periods of the trading day.

Generally the system performs well for its current levels of activity although some users have complained of slow response at key times. In addition, some functions are restricted because of their potential for overloading the system.

CDS' activity levels are in line with the growth projections made during the system's design phase. Its all-time high was 1174 trades in one day. The market and its trading activity is expected to grow dramatically (barring any significant outages or failures) over the next few years. It is unlikely that the system will be able to accommodate this growth without increases in its capacity. As this growth occurs, presumably the CSE's ability to afford to expand its system capacity will grow accordingly.

One reason for slow terminal response is the system's internal competition for resources. During operation, multiple tasks within CDS access the same files and functions concurrently. System capacity and performance are clearly limited by disk capacity and slowed by contention for its use. The production of large reports and logs, especially those requiring heavy access to the data base, can also impact performance.

It is absolutely clear that a second disk drive is essential for reasons of capacity, performance and backup. The slow response problem should be somewhat alleviated (perhaps substantially) by the recommended addition of a second disk drive. CDS' data processing people plan on moving the Audit files and logs and certain other files onto the second disk (when it is acquired) so as to improve performance.

**CSE's Central Depository System**

**June 22, 1992**

Computer memory is another important factor in performance. Its use should be periodically reviewed as part of CDS' ongoing system tuning efforts. The system has 12 MB of memory which is a reasonable amount. A mix of programs is kept in memory at all times. The CDS system uses one update program to serve every 5 users. Whenever memory is full and additional space is required for a program or data, the computer Operating System pages (writes) out segments of least-recently-used memory to disk and then allocates the freed memory to the requested functions. This paging activity can lead to problems of fragmentation with a corresponding drain on performance.

Performance will continue to change as new issues, brokers, custodians, investors and functions are added. It will also be affected by trade and quote activity increases.

These anticipated changes make it imperative that the data processing department develop a performance monitoring capability. It should include a means of predicting system performance under certain activity levels as well as a means of testing those projections and of verifying the efficacy of changes made to improve performance. This may necessitate developing a test system that could be used for stress tests and capacity tests. The goal of these efforts should be to provide a capacity that always exceeds the exchange's growth rate and the floor's reasonable ability to execute trades.

It is likely that Unisys has mathematically modelled the hardware and system software used to run the CDS system. Thus it may be worthwhile to ask Unisys if they could (would) develop a model of the CDS application. Their income from CDS is undoubtedly too small to warrant full-blown modelling but perhaps its attractiveness to other markets around the world would make some level of assistance worthwhile.

**3.4 System Security**

The integrity of Sri Lanka's equity market is totally dependent on the CDS system. At the moment, the market is small enough that errors and violations are likely to be quickly detected and can be reasonably researched manually. Nonetheless, the system's security needs tightening especially given the anticipated growth in trading volume and numbers of securities and market participants.

One major difficulty in maintaining system security is keeping its procedures from interfering with legitimate access. Another is protecting against dishonest or malicious personnel having access to system internals (e.g. able to bypass system protection and/or break the system locks undetected). As Juvenal so aptly put it many centuries ago: "Who will guard the guards themselves? - Quis custodiet ipsos custodes?".

CSE's Central Depository System

June 22, 1992

A recurring question has been, Can the broker (or anyone else) evade the CDS system's security features. The strictest answer is not without difficulty. The author believes that no system can be absolutely secure against accidental or purposeful damage and/or violation of its files. With this in mind, the following philosophy of security is proposed:

- \* The cost to a violator, whether thief or other, should greatly exceed the violator's potential gain.

To achieve the highest possible level of security consistent with reasonable ease of access, the following is proposed:

- \* The system should alert its operators and/or users to any attempts at unauthorised change,
- \* The system should inform all users when new versions are implemented and that information should be consistent with user expectations,
- \* The system should include a mechanism for verifying at start-up that not one bit (computer jargon for binary digit, the smallest possible component of data) in any file or program has been changed since their last use except as specifically authorised and reported,
- \* The system should log, preferably on non-erasable media, all transactions and all activity,
- \* The operating system log should also be recorded on non-erasable media,
- \* All logs should be searchable using computer assisted search techniques,
- \* It should be possible to, at any time, reconstruct the system, its files and any activity against those files,
- \* Each user and each participant should have hard-copy records of their activity and balances,
- \* A standard program of on-going file synchronisation with each of the CDS' major interfaces should be implemented. It is particularly important that the CDS regularly (perhaps monthly) balance its records against those of the registrars and/or company secretaries for each of the securities it holds,
- \* System security should be a clear assigned responsibility of a senior person with data processing experience. That person should have a reporting relationship to an Audit Committee of the CSE's governing Board.

The relative security of the CDS system is good but by no means is it completely adequate. Some of the system's security features are described and commented below. However a total security audit is beyond the scope of this review. What is needed are ongoing security reviews periodically performed by system competent personnel.

Access to the system and to functions within it is protected by a password process that is reasonably effective. The passwords are stored in encrypted form and are never in clear text. How

**CSE's Central Depository System**

**June 22, 1992**

often or whether the system requires users to change their passwords is unknown. Most system auditors call for passwords to be changed at least once every few months.

The CDS system and its files are backed-up (a copy of the entire contents of the CDS disk is written to tape) at the end of each day's activity. Two copies are made with one kept in the computer room and the other sent to storage in an off-site fire-proof bank vault. Month-end backups are also taken. The daily backup tapes are retained for a only a few days. The crucial questions are: is the retention period adequate? Can the system be completely recovered at any time from these tapes? What is done if one or more files/tapes is unreadable?

The source code to the system is maintained on disk with copies kept on magnetic tape. The tapes are stored in the aforementioned off-site bank vault. A paper copy of the source code is kept in the computer facility for programmer access. This is probably adequate but a procedure should be established to periodically verify the correctness, completeness and usability of these tapes and whether or not it is possible to backup to earlier versions of the system.

The CDS system is currently being maintained by BC Computers. CDS' programmers do not yet have the capability (or the self-confidence) to yet maintain the system themselves. The CDS programmers are primarily engaged in writing special ad hoc reports. Apparently the Query language that comes with the system software is a resource hog. Curiously enough, the programmers seem to enjoy write as well as read access to the files. Report programs should never have write access.

To the degree possible, the development and test system should be segregated from the production system. A formal acceptance procedure (for new versions of the software) should be implemented. At a minimum it should provide for the easy fall-back to an earlier software version should a new version appear unstable.

At present, CDS uses only the computer Operating System's security services. The data processing manager plans on implementing additional security features.

Time-stamps of the usage of each and every file in the system is kept in an on-line Control file. This could be a useful tool for detecting unauthorised after-hours access to the system and its data. The on-line audit file seems quite excellent. For every update transaction, the system logs the record being updated both before and after the update along with the transaction itself.

A worthwhile improvement to the controls within the system, would be to modify the CDS software to generate statistical counts that could be easily verified manually. These would include counts of shares traded and shares deposited, etc. by broker, by security, etc.) for each trading period. These would be added to

the previous days counts to create a cross-check which should be manually verifiable on at least an occasional basis. If these were added to the published daily reports, the chance of catching errors would be greatly enhanced. This is because interested parties (investors, listed companies, etc.) would likely be examining the published reports quite diligently. It might also be worthwhile to develop means by which market statistics such as market indices and movements would be continually checked manually for accuracy.

The author strongly recommends that all logs be written to machine readable but non-erasable media. It is difficult to keep the truly determined from violating a system. It is also difficult to detect certain kinds of violations. It is extraordinarily difficult however, to trace and/or recover from such events if the logs have been erased or corrupted.

One way to enhance CDS' audit capability (and recoverability from improper access) is to record all log data onto non-erasable optical disk media using WORM (Write Once Read Many) drives. The permanence of this media (once written it cannot be overwritten) makes it ideal for Log and audit functions. These disks are excellent tools for permanently recording snapshots of CDS' data base which can be used to recover from catastrophic failures. Furthermore those logs can be easily searched using generic search programs.

Optical disks are small, have enormous capacities and are easily stored. Some are the size of music CDs (compact disks - indeed the same technology is used) while larger systems use 12 inch "platters" in so-called data "jukeboxes". Huge quantities of data can be stored on an optical disk platter. The drives and the disks are relatively inexpensive.

Both "images" (pictures of the data as it appears on a page rather than its digital or computer readable form) and digital data can be stored on this media.

### **3.5 Issues of Privacy**

Users of the CDS need to feel that their ownership records are kept private. This is generally accomplished by restricting access to system files and parts of files to those with a legitimate need to know. The system generates a number of reports that are less easily controlled however.

Two copies of a list of all client holdings, by broker, (Daily Client Listing) is produced each day. One is printed at the end of each day and the second is printed at the start of the next days run. The separation is to minimize the tie-up of the printer and to eliminate the need for an operator to work late solely to man a printer. One copy serves as an archival record for CDS and the other is given the brokers so that they may research a

## CSE's Central Depository System

June 22, 1992

clients holding prior to executing a sell order. These are also considered a level of protection against a system or computer outage that prevents access to the electronic records.

This is a voluminous report which can only grow much larger over time. Its very size makes disposal without compromising privacy a difficult proposition. This report should be eliminated and replaced with controlled on-line access or other alternative measures as soon as possible.

### **3.6 Remote System Access**

A long term objective of the CDS is to make its system and services in Kandy and other cities beyond Colombo. The CDS system is designed to provide brokers remote access from their offices via PC-based terminals. Other participants (e.g. custodians and registrars) could conceivably benefit from remote access but those benefits are more distant. The plan is to directly connect the PCs over leased telephone lines although provision is being made for dial-up service

The design seems to be oriented towards terminals controlled by the CDS computer rather than a more distributed (processing load and/or data shared or distributed over multiple computers) approach. The needs of the participant for computer readable data argues for greater local processing capabilities at the broker offices. The system provides for the downloading (transmission of files from the CDS computer) of data to participant PCs. This service ought to be expanded to provide a greater range of services (e.g. enable the users to process CDS-generated data at the own offices).

The downloading of data to participants could be a (partial) solution to the problem of a lack of a backup for the line printer. Instead of printing participant reports the system would transmit them directly to their users who would either print them or store them as on-line files in their systems. If the reports are used as an information source, then it is probably preferable to receive them in electronic form and avoid the labour and potential errors inherent in keying from paper reports. Some of the advantages of this service are:

- \* Speedier delivery of reports to the participant's office and elimination of the messengering of transmitted reports.
- \* Reduced load, and coincidentally reduced paper costs, on the CDS computer system.
- \* Provision of usable raw data (the report input) to participants for their own processing.

CSE's Central Depository System

June 22, 1992

**3.7 Comparing CDS with other Depository Systems**

CSE's Central Depository System or CDS compares favorably with the systems employed by other Capital Markets worldwide. Indeed, the mere existence of a Depository can be said to be an improvement over other markets.

The best means for comparing CDS' capabilities and features with those provided by other equities markets is to compare how each is meeting international standards. The most widely accepted standards are those promulgated by the Group of Thirty (G-30), an independent, non-profit organisation of business people, bankers and representatives of financial institutions from 30 developed nations. G-30 has published 9 recommendations for the world's securities markets which they state are aimed at "maximizing the efficiency and reducing the cost of clearance and settlement," and thereby reducing risk. A chart comparing Sri Lanka's adherence to these recommendations with that of twenty-one other countries is shown in Figure 3.1. The Group of Thirty's 9 recommendations are quoted below. Observations as to CDS' meeting of those requirements are italicized.

- #1. By 1990, all comparisons of trades between direct market participants (i.e., brokers, broker/dealers, and other exchange members) should be accomplished by "T+1".

*The CSE, improves on this recommendation by "locking-in" its trades on trade day or "T".*

- #2. Indirect market participants (such as institutional investors, or any trading counterparts which are not broker/dealers) should be members of a trade comparison system which achieves positive affirmation of trade details.

*The CDS does not provide this capability. It is however an important service to international investors. This is more fully discussed in section 4.5 Institutional Investors (Participant Perspectives).*

- #3. Each country should have an effective and fully developed central securities depository, organized and managed to encourage the broadest possible industry participation (directly or indirectly), in place by 1992.

*This is precisely the thrust of the CDS. The CDS overcomes the chief objection to depositories which is that they make it difficult for a company to know who are its beneficial owners. This is because the company secretaries and/or registrars generally know only a depository's nominee name as owner and many depositories only know the identity of the broker or custodian. By contrast, the CDS requires that it know beneficial owner and provides this information to the company secretary or registrar on request.*

**CSE's Central Depository System**

**June 22, 1992**

- #4. Each country should study its market volumes and participation to determine whether a trade netting system would be beneficial in terms of reducing risk and promoting efficiency. If a netting system would be appropriate, it should be implemented by 1992.

CSE's trade volume does not warrant going through the expense and effort required to implement a viable netting system. Furthermore the system settles effectively on a trade-by-trade basis.

- #5. Delivery Versus Payment (DVP) should be employed as the method for settling all securities transactions.

The CDS does not observe this requirement. Physical settlement (jargon for delivery of shares) effectively occurs on Trade day when CDS debits the sellers account and credits the buyers account. Money settlement occurs on T+7. Because this practice seems at odds with the function of DVP, international investors may consider it a market disadvantage.

- #6. Payments associated with the settlement of securities transactions and the servicing of securities portfolios should be made consistent across all instruments and markets by adopting the "same-day" funds convention.

Some markets use "same-day" funds (the payment is final on the same day), while others use "next day" funds for settlement. CDS is effectively a same-day practitioner in that settlement funds must be on deposit at the clearing bank on settlement day and debits and credits are effected on that day. Custodians achieve the same result through the use of Central Bank cheques. While same-day funds is a desirable concept in its own right, it is inextricably bound with other payment and banking issues including Group of Thirty recommendation number 5 - Delivery Versus Payment (DVP).

- #7. A "Rolling Settlement" system should be adopted by all markets. Final settlement should occur on T+3 by 1992. As an interim target, final settlement should occur on T+5 by 1990 at the latest, save only where it hinders the achievement of T+ 3 by 1992.

Rolling Settlement is the practice of settling trades every business day as contrasted with Account Settlement which uses one or more designated days per trading period for settlement. With the creation of the CDS, the equities market in Sri Lanka has moved from Account Settlement every fortnight to a rolling settlement on T+7. Reducing this to T+3 is probably not a practical step at this time. It is the author's view that the Group of Thirty's timetable is extraordinarily ambitious for all but a few markets because

**CSE's Central Depository System**

**June 22, 1992**

*of the difficulties the internationally minded institutional investor encounters in receiving confirmations of trades and affirming their correctness. This activity is further constrained by large time zone differences between investor and market.*

- #8. Securities lending and borrowing should be encouraged as a method of expediting the settlement of securities transactions. Existing regulatory and taxation barriers that inhibit the practice of lending securities should be removed by 1990.

*In general this recommendation does not apply to CDS. Lending and borrowing are generally used as a tool to satisfy a market participant's obligation to deliver securities to a trading counterparty when those securities are late in being delivered or are otherwise unavailable. Since CSE's rules require that a seller register his or her shares in the depository before being sold, a "failure to deliver" cannot, in the strictest sense, occur. Should the CSE change its rules and permit market-making or otherwise allow short-selling, this recommendation should be immediately revisited.*

- #9. Each Country should adopt the standard for securities messages developed by the International Organisation for Standardisation (ISO Standards 7775). In particular, countries should adopt the ISIN numbering system for securities issues as defined in the ISO Standard 6166, at least for cross border transactions. These standards should be universally applied by 1992.

*The CDS follows ISO Standard 6166 which applies to International Securities Identification Numbers. It does not at this time use ISO Standard 7775 which applies to Securities Message Types. These are worthwhile goals which few markets even remotely meet mostly due to the difficulties inherent in changing old computer software. Markets everywhere are pursuing these standards albeit at a glacial pace. The CDS should continue its pursuit of these goals.*

**CSE's Central Depository System**

**June 22, 1992**

**Table 3.1 Group of Thirty: Status of International Recommendations Equities**

Recommendation #	1 Comparison on T+1	2 Positive Affirms	3 CBD	4 Securities Netting	5 DVP	6 Same-day Funds	7 Rolling Settlement	8 Securities Lending	9 ISO/IBIN
Australia .....	Yes	No	No	No	Yes	No	Open	Yes	No
Austria .....	Yes	No	Yes	No	No	Yes	Weekly	No	No
Belgium .....	No	No	Yes	No	Yes	Yes	Fortnightly	Yes	No
Canada .....	Yes	Yes	Yes	Yes	Yes	Yes	T+5	Yes	No
Denmark .....	Yes	No	No	No	Yes	Yes	T-1	Yes	No
Finland .....	Yes	No	No	No	Yes	No	T+5	No	No
France .....	Yes	No	Yes	No	No	Yes	Monthly	Yes	No
Germany .....	Yes	No	Yes	No	Yes	Yes	T+2	Yes	No
Hong Kong .....	Yes	No	No	No	Yes	No	T+1	Limited	No
Italy .....	Yes	No	Yes	No	Yes	Yes	Monthly	Limited	No
Japan .....	Yes	No	No	Yes	Yes	No	T+1	Yes	No
Korea .....	No	No	Yes	No	Yes	No	T+2	No	No
Netherlands .....	Yes	No	Yes	Yes	Yes	No	T+5	Yes	No
Norway .....	Yes	No	No	No	Yes	Yes	T+6	No	No
Singapore .....	Yes	No	Yes	No	Yes	No	T+5	Yes	No
Spain .....	Yes	No	No	No	No	No	Weekly	Limited	No
Sri Lanka .....	Yes	No	Yes	N/A	No	Yes	T+7	N/A	Partial
Sweden .....	Yes	No	Yes	No	Yes	No	T+5	Yes	No
Switzerland .....	Yes	No	Yes	No	Yes	Yes	T+3	Yes	No
Thailand .....	Yes	No	Yes	Yes	Yes	Yes	T+4	No	No
United Kingdom ..	Yes	Yes	No	Yes	No	Yes	Fortnightly	Limited	No
United States ...	Yes	Yes	Yes	Yes	Yes	No	T+5	Yes	No

Primary Source: Congress of The United States Office of Technology Assessment

Other international groups have endorsed (for the most part) these recommendations and have added two others. The Federation Internationale des Bourses de Valeurs (FIBV), the International Society of Securities Administrators (ISSA) and the European Community (EC) have recommended that:

- \* Cross-border Central Securities Depositories should be linked, and
- \* Securities should be immobilised in the country of issuer.

It is too early in CDS' history, or indeed that of other regional depositories, to achieve effective or useful linkages. The second recommendation is effectively achieved by the CDS.

One additional note. These international groups can be very helpful to the markets in Sri Lanka. The CDS should report its progress in establishing its depository to the Group of Thirty which, in turn, would publish and distribute worldwide that information. The CSE may find it beneficial to join the FIBV as an excellent way of gaining useful ideas and the SEC may find it worthwhile to join the International Organization of Securities Commissioners (IOSCO).

## CSE's Central Depository System

June 22, 1992

### 3.8 Trade Reporting Issues

Contrary to the practice at most exchanges worldwide, CSE's trades are not reported real-time. They are gathered and key entered in batches (see section 2.3 CDS Floor Support Procedures). This is likely to prove disadvantageous for a number of reasons including:

- \* Trades are reported in sequence but the actual time of a trade cannot be known with accuracy,
- \* The manual efforts associated with trade reporting might be unwieldy and overly time consuming in busy markets,
- \* Special efforts are required to maintain trades in their execution sequence,
- \* The trade surveillance process is more difficult to accomplish when trade data are not real-time,
- \* Market data vendors and other subscribers to exchange data expect to receive delayed data for free while they are accustomed to paying for real-time data,
- \* International investors are frequently suspicious of markets that do not report their trades real-time.

Actually trades are reported twice, once when they are keyed from the Whiteboard and once from the Pro Forma sheets. In addition the brokers on the floor must each separately record his understanding of the trade's details for reporting back to his firm. It might be preferable and simpler to replace the present trade reporting procedure with a real-time one.

One way to speed up the process might be to employ a three-part trade reporting ticket. The original would be used to report the trade to the exchange, the second copy would go to the buyer and the third copy would be the sellers.

Reporting would be the selling broker's responsibility. He or she would be required to report the trade immediately, for example within 90 seconds (the rule in the U.S.). The selling broker would fill out a trade ticket, time-stamp it using clocks on the floor provided for this purpose, give the original to a Floor Reporter (the CDS terminal operator) and give a copy to the counter-party to the trade. This would eliminate the need for brokers to write separate trade reports for their own use. Both brokers would however, be required to verify that the trade ticket is correct.

All trades would be keyed on the floor as soon as received. One or both of the data entry people who now key and verify the pro forma sheets would be moved to the floor to assist the present floor terminal operators. After keying, the Floor Reporter would time-stamp the ticket. These would then be saved for audit and research purposes.

TO :  
FROM :

PHONE NO. : 574364

APR 8 1993 11:20AM P 9  
PHONE NO. : 0

## CSE's Central Depository System

June 22, 1992

Just as with the present system, the brokers would be required to verify that the trades as keyed into the system are correct and agree with their own records. To help brokers more accurately identify their trades a trade ticket numbering scheme could be implemented. This would entail the Floor Reporter keying an identifying number for each trade (for example: a pre-printed number or a number or code manually entered on the ticket).

Some distinct advantages accruing from real-time reporting are:

- \* Each trade would be keyed only once;
- \* Fewer people would be tied up in trade reporting,
  - The Trading Post Manager would cease filling out batch sheets and could attend to other duties such as monitoring trading,
  - The buying and selling brokers would not be required to spend time at the Trading Post Manager's desk to report their trades,
  - The batch control clerk need not log in the Pro Forma sheets as these would be eliminated;
- \* The Floor procedure would be speeded up. For example, since each party to a trade would have a copy of the hand written ticket and would know that all trades were keyed within 90 seconds, there would be no need to await the printing of run sheets before entering client ids;
- \* It would be easier to create a real-time ticker tape (both human and machine readable) which might be a useful addition to the exchange's repertoire;
- \* Real-time prices can provide a pricing source for automated or computer-assisted trading;
- \* Market surveillance is easier to achieve and more readily automated with real-time pricing.

### 3.9 Market Data Reporting

Exchanges are an important source of market information. The reporting of its market data is a crucial function of an exchange. Indeed it would be difficult to achieve broad participation in a market without widespread geographic dissemination of that market's most basic data such as bids, offers and most recent prices (dubbed last-sale by the industry). Without these data, investors cannot monitor the market unless they are on the floor itself.

The Sri Lanka equities market needs a real-time price and quotation service. It needs a way for investors to know each quote and trade as it occurs without requiring a presence on the floor. In fact, it should not matter whether they are in Colombo or Kandy, Sri Lanka or Switzerland, accessibility should be the same. Furthermore these data should be continuously updated without requiring the constant entering of commands at terminal keyboards.

FROM :

**CSE's Central Depository System****June 22, 1992**

Because of restrictions within the LINC system software, the CDS system does not provide these data on a dynamic display basis. Instead new displays must be requested whenever users seek to find what new trades and quotes have been reported. This is a serious deficiency and should be corrected. It has been reported that one of the BC Computers technical people may have found a way to provide dynamic market displays. A second approach is noted below.

An effective and inexpensive way to provide these data on a worldwide basis would be to create some form of a ticker. This change would go hand-in-hand with the changes suggested in the previous section (3.4 trade reporting). As each quotation or trade report is entered, the CDS system would broadcast a report of it. Subscribers to this broadcast could receive it using simple PC-based systems (provided by the exchange or third-parties). These systems could be used to support dynamic market monitors, portfolio monitors, analytical routines, etc.

One difficulty in providing a data broadcast service in Sri Lanka is the limited availability of local loops (private telephone lines between the telephone company office and the customers receiving equipment). Apparently installing lines takes two to three months (if available and lucky) at a minimum and can take a year. This problem also affects installation of remote access service to the CDS system. The problem of limited data communications facilities is being addressed in Sri Lanka through the establishment of new island-wide public and private data networks (e.g. the Datanet company).

The broadcast could take any of several forms. The simplest would be via a ticker-tape (glorified teletype service). A more sophisticated form would be to broadcast it as a digital signal over satellite, FM radio signal or standard telephone lines. One advantage of radio or satellite is that, once the service has been established, installation at a customers site is rapid. No telephone installation is required. Furthermore satellite service is available that covers the entire Indian Ocean region and beyond.

Subscribers to a CSE data broadcast would be able to continuously and dynamically monitor the Colombo market at virtually little cost to the exchange. Since communications is one-way, no incremental load would be placed on the CDS computer, beyond the initial write of a record, regardless of the number of users receiving the broadcast. The broadcast would be even more valuable if corporate announcements (e.g. dividends, etc.) and other market information were included.

One means of disseminating these data to brokers and investors across Sri Lanka would be to piggy-back the broadcast on a television or radio signal. On television, the interval between frames broadcast by the studio (the space between pictures when the picture appears to be rolling) known as the vertical blanking

## **CSE's Central Depository System**

June 22, 1992

interval or VBI can be used to carry data in digital form. Thus the VBI or a similar unused portion of a FM radio signal could be used to carry CSE's ticker broadcast. Perhaps the government television channel (assuming the TV signal is active during market hours) would be willing to carry these data as a public service until such time as the CSE could afford its cost.

To make these data usable, each subscriber would need a receiver antenna (even rabbit ear antennae would work in most metropolitan locations), receiver electronics to convert the signal and the computer logic to decode it. This can be achieved with modest PC gear. If Windows-type software (enables multiple tasks, each with its own display or window, to be run simultaneously) were used, the PCs could function both as a CDS terminal and a market data display terminal.

This is a service with significant value. The CSE could charge a fee for its real-time data especially if dividends and other corporate action data were included. The CSE might also find it useful to provide its data subscribers the software (for a fee) they need to receive, display and process its broadcast. A ticker display and monitor terminals could be placed on the floor and in the exchange's Visitors Gallery.

### **3.10 Market-Making**

At present, there are no marketmakers in the Colombo market. This is because exchange rules prohibit short-sales (the selling of securities not owned by the seller). In the future, this prohibition may prove to be overly limiting and undesirable. Marketmakers, where they exist, can provide liquidity to a market and greater instantaneity of execution. They, in effect, smooth out the temporary imbalances between supply and demand.

While this may not be an immediately desirable feature, provision for marketmakers should be made in any future design enhancements of the CDS system. At a minimum, the system should not preclude this function's existence.

### **3.11 Immobilisation without Certificates**

The CDS has chosen to immobilise securities without actually holding any certificates. Instead it asks the Registrar or Company Secretary to transfer deposited securities into CDS' "nominee name" on the Company's books but to not issue any certificates. In the vernacular of the industry, the Registrar becomes the CDS' Transfer Agent Custodian or TAC.

The success of this procedure is only as good as the weakest link. CDS' records can never be in lockstep synchrony with those of the Registrar. At a minimum, the Registrar receives transfers a day or two after being processed by the CDS system. Generally

**CSE's Central Depository System**

June 22, 1992

they are considerably further behind than that. The only time formal efforts are made to synchronise records is when dividends, rights, bonuses or other corporate actions requiring exact information on ownership are declared.

It is probable that if the Registrar's records showed different balances than did the CDS system, the courts would likely rule in favor of the Registrar as the official record unless the Depository could establish its claim beyond all reasonable doubt.

Thus it would seem imperative that the CDS adopt a mechanism for balancing its records with those of the Registrars on a regular standardised basis and that it have a means for tracing all transactions between them. The CDS has taken some steps in this direction. It has added to the deposit reports it sends to the Registrars a totals line showing the number of shares (in the security being deposited) it calculates are held by the Registrar as of the acceptance of that deposit. This is, however, no requirement that the Registrar acknowledge or confirm these assertions. The CDS should address this issue as soon as possible.

**3.12 Sri Lanka as a model**

The CDS system has capabilities other exchanges around the world need and/or desire. That system could therefore serve as a model. Such an action would benefit both the exchange and the international trading community. The system might also be a source of modest royalties (for its design). Several countries such as Venezuela, Columbia, Pakistan, Indonesia and several other exchanges including several from the Asia-Pacific region are seeking to automate their settlement and post-settlement processes. The key to both Sri Lanka and these other markets is flexibility of design.

**3.13 Development Issues**

The CDS system has been developed using proprietary (Unisys) mainframe hardware and software. Mainframes are computers in which all computing power and data are centralised. While these tools have been effectively employed, it might have been wiser from a long-term perspective to have used "open-systems" (non-proprietary hardware and software).

For systems such as CDS, the general technological trend has been in the direction of distributed systems that are portable across the computers of multiple vendors. Another trend, particularly for on-line trading, has been the use of fault-tolerant (designed to continue functioning despite the failure of parts of the system) computers.

CSE's Central Depository System

June 22, 1992

A client-server architecture is a particularly relevant example of the trend away from mainframes. This concept employs PCs as (so-called) client computers to perform local, often customised, functions (e.g. floor broker support, broker back-office services, etc.) and larger computers as servers to provide common services such as settlement, trading, etc. These systems are generally linked together using Local Area Networks (LANs) within an office or campus environment and Wide Area Networks (WANs) for connecting to remotely scattered users.

Actually this is still an option. The CDS system is, in effect, a server although its terminals perform no independent functions. As CDS evolves over time, it may be desirable to implement new functions and services using a state-of-the-art distributed client-server architecture. The author recommends that the CSE seriously consider such a path for its future development projects.

CSE's Central Depository System

June 22, 1992

**4. Participant Perspectives**

The benefits of the CDS could be seriously diluted if market participants are unable to effectively employ it in their own operations. In most instances, the author has been able to interview only one or two of each participant type. In general there is a surprising degree of unanimity of opinion, and a quite positive one, about the CDS.

Because of the limited interview audience, the conclusions stated here may reflect an unintended bias. Nonetheless, it is believed that the following fairly reflects the perspective of the community of CDS users.

**4.1 Brokers**

The brokers interviewed believe the CDS works well and are generally pleased with it. As with any such system, they seek enhancements. Their observations are:

- \* They have serious doubts as to system capacity,
- \* Terminal response times are very slow,
- \* Account opening can delay trading,
- \* Ineligible issues do not benefit from CDS,
- \* The CDS cannot handle partly-paid shares,
- \* It has been hard to convert to rolling settlement.

A number of brokers have expressed a concern as to the system's capacity. In addition, their concerns have included:

- \* Lost, stolen and forged certificates,
- \* An inability to check accounts during the day,
- \* A need to rekey floor data into their systems.

Some brokers have said that the system is very slow. One broker claims to be experiencing 20 to 30 second response times. Even if exaggerated, this is probably noticeable by them because they need and use their terminals during the busiest time of the day. They feel especially pinched because they must pay penalties for not entering customer ID to their trades before the daily deadline and that is the time they most notice sluggish response times. This will of course become more critical as activity increases and new brokers join the CDS. One larger broker feels that trade volume should be considered before assessing penalties for lateness. They note that entering customer IDs for 200 to 300 trades per day (and growing) may be more than they can reasonably accomplish in the time available for the task. One partial solution is to enable earlier keying (see 3.8 Trade Reporting Issues) of these data.

The author believes that the addition of a second disk drive should alleviate, and perhaps eliminate, this problem. Nonethe-

**CSE's Central Depository System**

**June 22, 1992**

less after the second disk has been installed, performance tests should be performed to verify response times are at an acceptable level. If they are not, the system should be tuned to deliver proper service. It is recommended that performance monitoring and tuning be made a regular ongoing activity of data processing operations.

Brokers complain of delays in opening accounts and depositing certificates with the CDS. Some brokers seek an ability to open customer accounts from their terminals rather than through submitting paper documentation to the CDS. They note that these delays prevent them from responding promptly to their customers. Their customers seem particularly distressed when they cannot sell their shares because those shares are not held by the depository at sale time.

Securities that are not eligible for deposit in the CDS pose particular difficulties for the brokerage community because those issues gain none of the advantages offered by the CDS. Partially paid shares are the primary problem because of the CDS system's inability to process them. These represent such a small share of the market that it may not be cost-efficient to change the system to accommodate them. Nonetheless, this problem should be carefully researched.

It would appear that many retail investors have not readily adjusted to the change from fortnightly Account settlement to rolling settlement. Some clients continue to operate as before this change and, as a result, do not settle their accounts when due. This causes some problems as the broker must settle with the CDS regardless of whether or not customer-side settlement occurred. It is also more difficult to calculate interest due from customers when rolling settlement is used as compared with fixed date settlement every two weeks. For some brokers, significant software may be needed to alleviate this problem.

**4.2 Custodian Banks**

The custodian banks interviewed had quite positive views about the system and its effect upon them. Their observations are:

- \* CDS is a worthwhile improvement,
- \* They are concerned about broker access to their accounts,
- \* They seek an electronic link with the CDS,
- \* They want to discourage external trading,
- \* They seek a client affirmation capability.

The banks note that in the past they had as much as a two year wait on certificates and had paid brokers based on a broker note rather than the shares themselves. They feel that errors with the new system have been low except for wrong account numbers and wrong numbers of shares.

Concerns were expressed about the brokers being able to detect ownership of shares, to the general disadvantage of the custodians and their accounts. This is a universal problem with markets everywhere. It may be aggravated by the existence of a depository (especially so if privacy is not rigorously protected) but is not caused by it.

The custodian banks want an electronic link with the CDS primarily to improve their own service levels. They want to interface with the CDS through their own international proprietary networks. They would like to exchange settlement "receive", "deliver" and other instructions using ISO (and SWIFT) standard formats. They would also like to receive prices, quotations, announcements and other "official" information over the electronic links.

The banks feel that all trades should go to the market. They worry that if the settlement is inefficient, foreign brokers might be tempted to effect free transfers between themselves rather than trade through the market.

The custodians want the CDS to provide a mechanism whereby their clients can affirm trades performed in their name. They believe it important to be able to decline settlement. This is problematic since the CDS operates on the principle that "failed" trades do not exist. As a result, there are no buy-ins, sell-outs or other mechanisms for handling declined settlements. This is likely to be viewed as a serious deficiency by the global investment community. As such it will need to be addressed if the Sri Lanka market is to maximise its attractiveness internationally.

The banks also point out that banks which lend money against shares, previously held the certificates as collateral. Those same banks now worry about the security of their hold on the shares held by the CDS. Apparently, the explanations they have received about the pledging of shares is unsatisfactory to them. They seek a vehicle that stops share movement for those shares pledged to them.

#### 4.3 Clearing Bank

From the Clearing Bank's perspective, the CDS was a much needed improvement and they are pleased to be working with the CSE and CDS. Their observations are:

- \* The CDS has improved the market,
- \* It has run smoothly,
- \* The markets growth has been so significant as to be statistically startling,
- \* Trade cancellations should be disallowed,
- \* Legal procedures may need tightening,
- \* Overall risk issues need to be competently addressed.

## CSE's Central Depository System

June 22, 1992

To staff within the clearing bank, market growth has exceeded expectations given the number of issues being traded the low number of investors relative to population. Nonetheless, they expect even greater growth in the future.

The clearing bank's dislike of cancellations has to be weighed against the interests of the international investor (for whom cancellations and declined trades are sought). All parties need to be protected. Therefore it is incumbent upon the CDS to devise an answer to this dilemma.

The issues of risk are of vital interest to the clearing bank (and to nearly everyone else as well). They are working with the exchange and other in addressing these issues. They are refining a proposed "Articles of Association" to provide a well-defined settlement guarantee mechanism.

Bank personnel note that not all brokers are fully funded and must be provided overnight funds. The issue is how to provide appropriate safeguards for the funds being extended and for the market's overall safety and stability. They further note that exposures above a certain amount must be fully funded with cash or guarantees of payment on demand and without reference.

### 4.4 Registrars

From the point of view of one of the larger Registrars, the CDS was a great and necessary step but more needs to be done. Some general observations are:

- \* The registrar's books and those of the CDS can be only infrequently synchronised,
- \* Shareholder names can appear twice for the same securities,
- \* The registrars are concerned about the pressure for T+5 settlement,
- \* The CDS partially hides ownership.

Corporate registers are normally updated 2 or 3 times a month. The CDS updates its records each day based on deposits received and trades effected. Smaller registrars and corporate secretaries perform these updates even less frequently. It is therefore difficult for registrars to reconcile with the CDS in between their updates.

Shareholders often deposit only some of their shares with the CDS. Thus the registrar can see the same name twice, once in its own records and once from the CDS. In such instances they generally write two dividend checks or send out two annual reports, etc.

The registrar is responsible for detecting and rejecting invalid certificates (lost, stolen, forged, etc.) but would like the CDS to also perform a validity check. They are concerned about the

## CSE's Central Depository System

June 22, 1992

demand for faster return (by T+5 for deposits that are traded) of rejected certificates. They worry about the effect of vacations, holidays and sick leave on their ability to meet these targets.

Since the registrar only knows the CDS' name for those shares held in its name, the effect is to partially hide ownership information. They would like to a means of easily overcoming this problems.

### **4.5 Institutional Investors**

In general the Institutional Investor endorses the depository concept and is pleased with CDS' implementation. Since attracting investors to the Sri Lanka equities market is a goal of the CSE, it is important that the CDS be made efficient for them. These investors seek:

- \* A positive affirmation of trade capability,
- \* A means of allocating trades across multiple accounts,
- \* Accurate and timely market information,
- \* Notification of dividends and other corporate actions,
- \* Mechanisms for assessing risks.

The institutional investor wants direct control over their accounts. Most use multiple brokers, partly to get better service and partly for reasons of market (no one broker should know their total buying/selling interests or holdings) privacy. As a result, they are unwilling to be locked into any one broker. To control their accounts, institutional investors seek a positive affirmation of trade capability along the lines of the Group of Thirty's recommendation #2 (see 3.7 Comparing CDS with other Depository systems). To achieve this, the CDS will need to develop electronic links with their custodians and the international investor community.

Because of the distances and multiple time zones involved, this can be best achieved using the global networks of participating custodians or through one or more of the specialised value-added-network (VAN) providers. The CDS system would electronically routes confirmations of institutional trades to the trades's originator, the broker and the settling custodian(s). The institutions want an ability to affirm (or decline) these trades through the same network mechanism. This ability to decline trades must be carefully addressed as it is somewhat contrary to CDS' design prohibition against failed trades. All messages should be in the International Standards Organisation's (ISO) format for securities messages.

Institutional investors generally manage several accounts at the same time. They often buy or sell the same security for several accounts at a time. They therefore seek the ability to allocate a trade across multiple accounts. The CDS system cannot perform

TO :  
FROM :**CSE's Central Depository System****June 22, 1992**

this function as it treats each trade as belonging to a single account (individual or company).

The institutional investor wants accurate, real-time market information. This can be best achieved through the creation of a market data broadcast (see 3.9 Market Data Reporting).

A investment newsletter (Global Investment Technology) recently reported that fund sponsors and investment managers are losing "a small fortune in uncollected dividends" in their international investing. The CSE could help solve this problem for investors in Sri Lankan securities by establishing itself as the official source of corporate action (dividends, rights offerings, called bonds, etc.) data. It could effect this by requiring listed companies to provide it with all such information. Upon receipt it would encode the data in a standard format and include those data in its daily market data broadcast. This would have the added benefit of increasing the value of the CSE broadcast.

A major concern of the international investor is risk. This includes such themes as currency risk, settlement risk, systemic risk, etc. This makes it imperative that the CSE and CDS systems be made robust and secure and that the investor have the means of assessing their risks.

**4.6 Individual Investors**

The individual investor is an important part of the Sri Lanka securities market. For most, the primary interests are:

- \* Market price,
- \* Is the market fair and orderly.

For many, the CDS brings new, unfamiliar worries including:

- \* How to address broker control over their accounts,
- \* How to speed up the selling of stock held in certificate form,
- \* Against whom is a claim made if their broker or the CDS fails,
- \* Can the CDS help resolve old outstanding fails.

The issues of market price (timeliness and accuracy) and fairness are exchange responsibilities. These are best addressed through development of a real-time price and quote broadcast.

Market manipulation is a common concern of investors the world over. It is easy to suspect and difficult to detect. The CSE has established rules of fair trading. What it needs is a mechanism for detecting violations of those rules. The exchange should create an automated trade surveillance system and vigorously pursue insider trading and other violations.

CSE's Central Depository System

June 22, 1992

The most frequently cited concern, on the part of the investor, is a fear that under the CDS, brokers have excessive control over the investors account. This is the same sort of issue that motivated the Group of Thirty to recommend positive affirmation of trades for institutional investors. Many individual investors worry that their broker could sell their holdings without their knowledge or permission. This is tempered somewhat by the knowledge that the CDS system generates the trade contracts and monthly statements that they receive. Nonetheless, their worry is real and should be carefully and continuously addressed.

An investor cannot sell his or her stocks until they are registered in the depository. Often, this cannot be done until 2 or 3 days after the investor has delivered the shares to his/her broker. This is a new problem associated with the creation of the CDS. It is a simple delay occasioned by the logistics involved in moving certificates from the shareholder to the CDS. It is probably in CSE's interest to resolve it to the degree possible. This may necessitate changes to CDS' pre-trade procedures and software.

Since the concept of certificate immobilisation is new to Sri Lankan investors, they need to be persuaded that their holdings are safe. A number of investors have asked against whom would they have a claim should their broker (or the CDS) fail.

Prior to the establishment of the CDS, the market was plagued with settlement failures. Indeed, a number of investors claim that they have yet to receive their certificates from trades of two years ago. While this is a market problem, there appears little that the CDS can do except to exhort the brokers to try to resolve these claims.

**4.7 Listed Companies**

The companies listed on the CSE, and whose shares are held by the CDS, are primarily interested in:

- \* The value the market places on its shares,
- \* Who are its owners,
- \* Who is trading its shares,
- \* What insider trading might be occurring,
- \* How might they communicate with their shareholders.

Listed companies are vitally interested in the market price and activity levels for their shares. Most probably get their information from the daily newspapers. If the CSE establishes a market data broadcast, some companies may more actively follow the market. As trading volume increases, some may be interested in subscribing to monthly reports (paper and/or diskette) of trade and quote activity.

## CSE's Central Depository System

June 22, 1992

Aiding a company in determining who are its owners and who is trading its shares is a natural byproduct of the links between the CDS and corporate registrars. As the market matures, it may be worthwhile to specially flag the trades of corporate insiders. It should be noted that some companies feel that the exchange of closely held shares should be possible without the necessity of exposing those shares to market forces.

A CSE market data broadcast might be an excellent vehicle for companies to communicate with the market. Companies could send their corporate press releases (in a somewhat standardised format) over the CSE broadcast network. This could actually be a for-fee service.

### 4.8 Colombo Stock Exchange

The management of the CSE is, of course, vitally interested in all aspects of the CDS. They are especially concerned about the issues of system security. Management's questions can be summed up as:

- \* Can the system's security be evaded,
- \* What other checks and balances are needed,
- \* Can the system be insured against losses or damage.

The issues of security and checks and balances is discussed in section 3.4 System Security.

Management's interest in security is so keen that the exchange's General Manager acts as the CDS system's security officer (e.g. authorises access to specific functions). They wonder whether brokers (or other participants) can evade system security. As previously noted, that evasion is difficult but not impossible. The key is to make the cost and difficulty of evasion exceed its value to the perpetrator.

Most computer crime comes from using computers rather than penetrating their security. The CDS application cannot know whether a transaction is valid if it is properly entered by an authorised person. The system's checks and balances must provide for maximum chance of detection of improper activity. The CDS system achieves this by notifying those affected of any activity against their accounts. Determining how best to strengthen these checks is a proper on-going activity of the CSE's internal (and external) auditors.

CSE management has been unable to get quotes on insurance against system related losses and/or damage. This is probably due to the uniqueness of the CDS system which makes it difficult for an insurer to assess likely risk. The people with the broadest experience in this arena can probably be found at the Depository Trust Company (the largest CDS in the world) in New York City.

## CSE's Central Depository System

June 22, 1992

### 4.9 Securities and Exchange Commission (SEC)

The SEC's major concerns (about the CDS) are integrity, security and capacity. The SEC Chairman has asked that a study group be formed to urgently and thoroughly study these matters. He has asked:

- \* What is the level of backup and how might it be improved,
- \* Is the system secure against accidental or purposeful damage or loss,
- \* Does the system have the capacity to meet market needs,
- \* Is the staff adequate in size and qualifications,
- \* Is the system meeting the needs of the investor and other participants,
- \* Is the computer system state-of-the-art,
- \* How might the system be used to meet future (and broader) market needs.

Backup, system security and capacity are discussed in section 3. Some observations are in order however. The exchange has experienced phenomenal growth and has every reason to believe that growth will continue. This causes a broadening of these issues. For example, does the system have and/or can it support enough terminals to accommodate this growth? Do the CSE and CDS have sufficient space to house the people and systems needed to support growth? What about staff size?

The overall system has adequate capacity for the moment. It cannot however be expected to accommodate without change the double-digit growth that many are predicting. To address this, the exchange should develop a range of estimates of likely activity levels. It should then ask its data processing people, with the help of other departments (and oversight by a Board level committee), to demonstrate in a convincing way, the system's ability to meet those levels. Data processing is of course not responsible for such things as trading floor space but it has such a significant effect that these other questions almost cannot be answered without them.

Most of the data processing design and development work has been done by non-exchange people. The software vendor has performed competently. Regardless of whether the exchange intends on the continued use of contractors for this work, it needs its own technical expertise (see also sections 3.13 Development Issues, 5.5 and 5.6 Management Control).

The CDS has made remarkable progress in meeting the needs of investors and their agents. It has eliminated the worst aspects of the old manual procedures. Much remains to be done however. Such issues as investor concern about the absence of certificates and broker control over their accounts as well as the concerns of banks, registrars and other participants need attention. The exchange should organise user groups for the purpose of identifying and addressing the needs of the marketplace.

**CSE's Central Depository System**

**June 22, 1992**

The level of technology employed has met the CSE's most pressing needs. As noted in 3.13 Development Issues, the CSE's and CDS' systems should be migrated towards a more advanced architecture.

The CDS system will be an integral part of all future market development in Sri Lanka. Stabilisation, provision of a viable backup and capacity planning should be the next major efforts. The next steps are properly a decision of exchange management with guidance from its Board and User groups. The author recommends that high on the priority list should be the creation of a real-time market information broadcast and the development of electronic links with brokers and custodian banks.

CSE's Central Depository System

June 22, 1992

**5. Terms of Reference**

This section follows the original "Terms of Reference for a Comprehensive System Review of the CSE Computer System". In an attempt to be useful to the entire market rather than solely to those with a system perspective, a broader approach was taken. As a result, most of the issues posed by the Terms of Reference have been addressed earlier in this document.

**5.1 Internal Control Functions**

The following are the original Terms. Explanatory notes are in italics (see also 3.4 System Security):

- a. Logging of input data and recording of control information.

*The logs maintained are modest but appear adequate for present levels of activity. It is recommended that crucial logs (or snapshots) be recorded to non-erasable media.*

- b. Recording progress of work through the data processing department.

*Adequate for the size of the department and its activity levels.*

- c. Reconciliation of computer controls with other control information.

*Few controls beyond basic count and data entry edit checks exist. Trade information is published daily and is therefore subject to the light of public scrutiny. This would be enormously improved if the CSE were to create a real-time ticker as recommended in section 3.9 Market Data Reporting. With real-time reporting, clients who have initiated trades can often recognise when those trades have been executed.*

*The CSE holds its floor brokers responsible for verifying the elements of every trade. The CDS checks every account it opens and every deposit it handles against the original input documents but it expects the brokers and their customers to question any discrepancies they see.*

- d. Supervising distribution of output.

*The handling of output is effective but primitive. Data Processing operations personnel collect reports into groups*

CSE's Central Depository System

June 22, 1992

which are picked up by messengers from the brokers. Hand-over is person to person. Certain materials are signed for by the recipient. There are no lock boxes or other physical security scheme for these deliveries. The volume is small enough that this procedure appears acceptable but items of a confidential nature should be more formally controlled.

- e. Scrutiny of computer console logs (audit trails) and other control information entries in accordance with control instructions.

These logs appear to be scanned only when problems occur and research into their cause is required. This is probably acceptable given the enormous volume of messages in the logs and the very low probability of catching any problems with a visual scan. An added level of protection might be gained by writing the logs onto non-erasable media such as an optical disk (see 3.4 System Security) and using so-called smart programs to help scan for errors and anomalies. If optical disks are to be used, they should be kept in secure locked storage especially given their small size and consequent extreme portability.

- f. Liaison with users regarding errors, logging of corrections and recording corrections made.

Trade errors are returned directly to the Trading Post Manager who reported the trade for clarification and/or correction. Account opening errors, deposit errors, etc. are returned to the submitting broker. The process appears informal but functional.

- g. Scrutiny of error listing and maintenance of error log or error report.

No formal error listing or error log appears to exist. Errors detected by the system are recorded within the standard system and data base logs. These are scanned by the data processing manager and others whenever non-standard errors appear to occur.

- h. Identification and functioning of checks and balances in the system through independent outside checks, such as user departments and clients.

This is an area that needs strengthening.

Some CDS account holders are concerned that unethical brokers could sell their securities without their knowl-

CSE's Central Depository System

June 22, 1992

edge. The CDS system generates contract notes for every trade but some customers worry that these might be diverted. If a CDS account holder is suspicious that something is amiss, he or she can get their account balances directly from the CDS. This is useful but could not be considered a preventative measure except to the extent it might threaten perpetrators with early discovery.

The Institutional Investor community generally seeks tight direct control over their accounts. The author strongly recommends that the CDS consider establishing a system for positive affirmation of institutional trades along the lines of the Group of Thirty's recommendation #2 (see section 3.7 Comparing CDS with other Depository Systems and section 4.5 Institutional Investors - Participant Perspectives).

The CDS annual or periodic audit should verify activity and balances directly with account holders so as to improve somewhat the chances of detecting irregularities.

The CDS should establish a rigorous procedure for verifying its balances against those of the Registrar or Company Secretary for each of the securities it holds (see section 3.11 Immobilisation without Certificates). This is made imperative given the sums involved and the wide differences in when the CDS and the Registrars can process changes in ownership.

Procedures should be worked out with the brokerage community for the establishment of usable cross-checks between their systems and records and those of the CDS.

- i Assessment of in-country capability and plans for use of independent quality control evaluation, such as external auditors and information system specialist.

CSE's management has engaged a Sri Lanka firm to perform a security audit. This is clearly needed and it is likely that an in-country firm is the best choice given the special local circumstances that apply to security.

A local unit of an internationally recognised audit and consulting firm performed for the CSE and USAID an analysis of potential issuers of securities attitudes toward the Sri Lanka Market. Their work was competent and it is presumed their audit arm is equally capable.

It appears that Sri Lanka has a number of competent Information Technology (IT) specialists although their precise population is not known. What seems to be lacking are IT specialists with experience in the use of computers in the securities markets. This can be gradually overcome through

CSE's Central Depository System

June 22, 1992

training, working with other exchanges and the use of foreign guest lecturers and reviewers.

**5.2 Application Controls**

Review of controls operable at each of the following stages of the process flow.

- a. Off-line data entry, data collection including forms design, transmittal to processing and preparation for processing such as verifications.

*Not Applicable. All data are collected by the CDS system using on-line techniques. The CDS does not provide an off-line data entry capability.*

- b. On-line data entry, input processing data verifications, error handling, correction and resubmission.

*This seems competently handled. As the system is modified to perform new functions, these issues should be reexamined.*

- c. Processing program controls.

*Computer systems can mask errors because of the sheer volume of transactions processed and the difficulty in constructing readily verifiable cross checks. As the system is modified in the future, software controls should be implemented that enable the manual verification of the correctness of the CDS data base (see 5.1, item c. immediately above).*

*A test system should be developed which can verify that software changes made perform their assigned task correctly and do not otherwise corrupt the system or its files. A complete and robust test procedure is required. It should include unit tests (tests individual software modules before they are integrated into the system), integration tests (how well do the various software modules or units work together), volume tests, stress tests, etc.*

*Testing should be a formal and rigorous process. After the development personnel are satisfied that their changes are ready to be implemented, the code is "frozen" (NO further changes are permitted) and turned over to data processing operations and the users for Acceptance testing. Operations would conduct this phase of tests under the direct guidance of the affected user department with assistance from the internal auditor. If the system failed these*

CSE's Central Depository System

June 22, 1992

tests, the software would be returned to the development team and the cycle repeated. If it passed, the users would "sign-off" and the frozen software, would be installed into the production library and the immediately previous software version would be placed in a backup library.

d. Access to files and programs.

The paper copies of the programs are kept on a table in the computer room. This is not at all unusual. Since that room is considered a limited access facility and only known and authorised people are permitted entrance, this may be acceptable. It would probably be worthwhile to lock these in a secure cabinet during non-business hours.

Copies of the source code for the CDS system are maintained on tapes (primarily as backup to the disk files). These are kept in racks in the computer room. This is acceptable during the day, when staff are available to monitor access, but the tapes should be locked-away when they are not needed or the facility is unmanned. Since the backup tapes are stored off-site in a fire-proof vault, a fire-proof cabinet is not required.

e. Distribution of output to approved recipients and use of output.

See 5.1, item d. immediately above. As noted, output distribution is handled in a reasonable fashion. The volume of output seems excessive however for the amount of business being conducted. This issue is more directly addressed in the discussion of printer backup.

f. Batch control (where necessary) and/or audit trail considerations.

The manually calculated totals for batched transactions are visually checked by the entering terminal operator against totals calculated by the system. The system audit trail records before and after values for every update. These controls are quite effective. The audit log enables computer operations to research the effects of any transaction. This is useful in determining why the system behaved in a certain way when investigating errors.

CSE's Central Depository System

June 22, 1992

**5.3 Security and Protection/Provisions**

- a. Risk of damage due to ....(illegible in original) (sic) destruction of data files, programs or procedures.

It is presumed that what is being sought is protection against accidental or purposeful (malicious mischief) destruction. Sections 3.2 Absence of a Backup System and 3.4 System Security discuss this subject in detail.

- b. Access to computer facility.

The doors to the computer facility are not locked. It is continuously manned for around 12 hours each day. The building has around-the-clock guard service. Signs restrict access and data processing personnel ensure enforcement. It would be worthwhile to tighten after-hours security through installation of strong locks and intrusion alarms (for the computer facility and adjacent access halls).

- c. Current division of duties and proposals for change.

The CDS has too few systems staff to have an effective segregation of their duties solely for the purposes of security. Separating software development from operations is a logical step however. The software and files used in daily production should be accessible only by the operations staff. Conversely the development libraries and related files should be solely under the control of the development staff. Investigation into and resolution of production problems should be a joint development and operations effort.

Turnover of new releases of software from development to operations should be somewhat formalised. Development personnel should rigorously test their changes until satisfied that their software is ready to be implemented. The system and its source is then turned over to operations staff who place it in their own test libraries. The code is then considered "frozen", that is, no further changes are permitted. Operations with the help of the system's users conducts formal tests of the new software. At least one of those tests should mimic production if possible. If operations concludes that the new software is acceptable, it moves the then current production software into a fall-back library and replaces it with the new software.

In addition to this separation of duties and responsibilities, CSE/CDS' Audit Department should take an active role

CSE's Central Depository System

June 22, 1992

in monitoring the system. This should include performing design reviews to provide some assurance that the system is and remains robust and secure.

- d. Restricted access by operators to program documentation, data files and program files.

Discussed in 5.2, item d. immediately above. The operating system restricts access to authorised personnel using password control measures. It logs all accesses whether permitted or disallowed. It is difficult and sometimes counterproductive to restrict access by operators to all such material. The backup tapes are visible but only operations personnel are permitted to use them. These measures appear reasonable.

- e. Procedures to maintain the libraries, physical location of files, file labelling and checking out to authorised personnel.

The system libraries and files are maintained on disk. Two types of backup exist. One is a backup of the individual files while the other is a copy of the entire system disk taken at close of processing each day. The basic procedures of who may check out the libraries is loose as might be expected with an organisation as small as the CSE's dp department.

It is very difficult for the dp folks to physically arrange (segregate) the files kept on disk as only one disk exists.

- f. Fire protection including fire proof vaults.

The author wishes to note that he has no expertise in fire risks or protection. His comments on fire protection are therefore not definitive.

The building housing the exchange is old and subject to fire risks. Exit during a fire could be extremely difficult depending on the fire's location as the exit routes are narrow for the numbers of people involved. The exchange attempts to keep debris down but the danger is there nonetheless. These conditions must be considered carefully in light of the building's age and the need for maintaining physical security.

Backups to the system are sent each day to an off-site fire proof vault maintained by ANZ Grindlays Bank. These could be used to reconstruct a working CDS in the event the computer facility was lost due to fire. Only those transactions and activity which occurred since the backup was

taken would presumably be lost. Possibilities of this sort are a modest argument for off-site backup (see section 3.2 Absence of a Backup System).

Rapid recovery of the CDS system from destruction by fire depends primarily on immediate acquisition of a suitable site and quick delivery of a new computer.

Just over a year ago the Brussels Stock Exchange suffered the devastating effects of a fire that rendered useless its trading floor and its computer and communications facilities. Its computer vendor (IBM) and communications vendor (primarily the Belgian RTT or Postal and Telephone authority) performed yeoman's service in quickly bringing the exchange back into operation. It would be a useful exercise for CSE personnel to review with the folks in Brussels their experience and what they learned from it.

g. Off site storage of backup files and programs.

As stated in f. immediately preceding, These material are stored in an off site fire proof vault. The major questions are: How complete are these backups? and Can recovery proceed even if one of the tapes is defective?

#### 5.4 Contingency Plans

See also 3.1 Possible Single Points of Failure and 3.2 Absence of a Backup System.

a. Advance arrangements for back-up processing capabilities.

BC Computers Ltd. is obligated by contract to provide a backup computer for the failure of the CDS computer system. They have ordered (and may have installed) a system with the same hardware and software configuration as CDS'. A Contingency Plan should be developed and tested as soon as is practical. The plan should be tested periodically. This is especially necessary when one of the parties makes major hardware or software changes. Such tests should continue at least until CDS has its own operational backup system.

b. Redundancy in the existing system, for contingencies and proposal for hardware enhancements.

No redundancy exists in the present configuration. See 3.1 and 3.2 for recommendations of hardware enhancements.

CSE's Central Depository System

June 22, 1992

- c. Assessment of vendor plans and capability of emergency of replacement of spare parts and equipment repairs.

The availability of spare parts varies widely although it seems that delivery in most cases could be effected within one or two days. This is obviously less than optimum. Trained service personnel are generally available within a few hours.

**5.5 Information Systems Management Controls.**

- a. Assess the level and quality of the staff resources currently available and recommend the optimum level for a fully functional CDS. The consultant will also define training requirements, if any.

CSE and CDS have done well with the people resources available to it. It is however largely dependent upon outside resources, particularly those from ISTI and BC Computers. Before this circumstance can be addressed, a decision must be made as to what level of development is to be performed in-house and what is to be contracted out. The CSE must gain and retain control over its dp efforts. This can be done even while contracting for new development.

A strategic planner or systems designer is needed. That person would assume the responsibility (with guidance from management and the Board) for establishing the overall direction of the CSE's and CDS' systems direction.

An audit capability is needed (no auditor is shown on the CSE organisation chart). A security officer is needed. Perhaps these two functions might be combined.

A systems person with diagnostic skills and knowledge in the internals of the operating system and the data base management system being used is also desirable.

The most pressing training needs are for trading, settlement and post-settlement skills. It might be worthwhile and inexpensive for the CDS to work out a cross-training arrangement with its brokers, custodians and registrars. Useful self-study material and guides are available from the New York Institute of Finance (70 Pine Street; New York, NY 10270; USA; phone 1-212-344-2900).

The programming and operations staff would benefit from training in structured design, data base, project control and testing. The training offered should be particularised to the staff's needs and should help prepare them for the transition to new systems architectures.

CSE's Central Depository System

June 22, 1992

- b. Review the existing schedule and workload of data processing staff.

The data processing department's schedule appears to be effective. As responsibility over the CDS software is assumed, programmer assignments will become more complex and will require closer oversight.

- c. Control over program resources of the installation such as documentation and program change controls.

To date nearly all documentation has been provided by ISTI (contractor to USAID) and BC Computers. That documentation is quite comprehensive and usable although it does not appear to have been placed in a formal library or file. All documentation should be gathered together and organized into a coherent and complete library. These should be maintained in both paper and computerised (word processor output) form. The computer version would be used as a set of files that could be searched automatically. Users reading the electronic version could annotate their thoughts and/or changes (without changing the original) directly into the documentation. Computer specialists dub this electronic documentation process Hypertext.

There are no written program change control procedures. This should be corrected as soon as practical. This could be done by adopting the written procedures (system development life cycle or similar) of other organisations having similar on-line real-time systems. If this is not practical or readily done, these can be written as a joint effort of programming and operations personnel.

- d. Control over computer files, specific attention should be given to security procedures with regard to program and file library, file retention and file reconstruction plan.

Procedures are in place for the maintenance and backup of data files and program source files. Two generations are kept of most files. It is probably desirable to increase that number to at least three.

The retention period for archival files does not appear to have been established. The CDS is so new that the archives have never been purged. Market price and quote history should be kept more or less permanently (many market participants use these historical records to chart market movements and the like. The retention period for other files would be dependent upon legal requirements. Responsibility for this should be assigned the Auditors.

June 22, 1992

CSE's Central Depository System

No formal reconstruction plan exists although staff, with vendor support, appear competent to rebuild the system and/or its files. A written plan should be developed so as to eliminate dependence upon any one individuals memory or availability.

- e. Control over the development life cycle of new applications.

The system was developed using traditional life cycle practices of feasibility, design, RFP, selection, development, test, etc. However no procedures have been established for maintenance and enhancement. The mechanics of development and maintenance remains under the control of the developer of the system BC Computers Ltd.

The CSE has begun to explore how it might best assume responsibility for development and maintenance of the system. A system development life cycle procedure should be adopted. It should be formal enough to provide clear management control over the process yet loose enough to avoid the problems of bureaucratic procedure.

A crucial need will be to develop a strategic plan and a mechanism for setting development priorities.

- f. Control over maintenance (correction and revisions) of existing applications.

Same as immediately preceding item e. See also section 5.3 item c.

### 5.6 Top-Level Management Control

- a. Procedures set up for major additions or changes.

The CSE needs a mechanism for deciding what enhancements, additions or changes should be made to the system.

The CSE should develop a clear definition of its mission and that of its CDS system. A mission could be postulated from the questions and active interest expressed by many of the market's participants. From their perspective, CSE's role is one of a service organisation whose function is to develop and maintain an efficient, fair and orderly market for securities and to use that market to attract investment in Sri Lanka.

Translating its mission into a concrete strategy and action plan is the next step. CSE's various constituencies (e.g.

brokers, custodians, institutional and international investors, issuers, registrars, regulators, retail investors, staff, etc.) all need to be considered. It may be desirable to establish one or more user committees to help establish the most important goals.

Strategy is, of course, a Chief Executive and Board level responsibility. Nonetheless, the CSE should assign someone the day-to-day responsibility for establishing and implementing its strategy.

- b. Procedures for system performance monitoring by the top-level management.

The dp department should establish a standard daily operations report to senior management detailing the previous day's (it could also be an end-of day-report) activity. The report should contain that information which senior management believe it needs to monitor the health and vitality of the CDS system. At a minimum it should have usable statistics such as numbers of trades, deposits and other transactions; number of shares traded and deposited; value of the above; most active shares; etc. The report should also contain a brief description of significant events, problems encountered and their solutions, etc.

The dp department should also regularly measure how well the system performs in terms of response time to inquiries, trade entries, etc. These measurements are needed to ensure that the CSE is prepared for sudden increases in volume, etc.

In addition to the above, the exchange should regularly poll its participants to determine how well it is serving their needs.

- c. Comparison/evaluation of the capabilities and features of the CDS system with other comparable CDS systems.

This is extensively discussed in section 3.7 Comparing CDS with other Depository Systems.