



READINESS TEST PROCEDURES

HKEx Orion Market Data Platform Securities Market & Index Datafeed Products (OMD-C)

Version 1.0
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1 Introduction

HKEx Orion Market Data Platform (“OMD”) is developed to provide real-time market information in digital form. The Information Vendors and Exchange Participants/End Users, collectively referred as “Clients”, can subscribe to the services of OMD to receive real-time digital market data from HKEx.

Clients intending to make direct connection to the OMD host to receive market data are required to complete a Readiness Test conducted in the HKEx Open Test Environment with positive results. The Readiness Test aims to facilitate Clients’ verification of the technical readiness of their feed handlers for receiving and processing OMD messages.

This document specifies the testing procedures in the Readiness Test for **Securities Market and Index Datafeed Products (OMD-C)**. The Readiness Test in this document is not applicable to the Mainland Market Data Hub (MMDH) for which a separate document on Readiness Test Procedures will be prepared.

HKEx reserves the rights to change and fine-tune the Readiness Test requirements from time to time.

The intended readers of this document are the technical personnel of the OMD Clients. In order to be granted direct access to the OMD host, Clients must submit a completed declaration form for their readiness. The authorized person for the declaration should also read this document to understand the Readiness Test requirements.

2 Pre-requisites

Clients are required to fulfill the pre-requisite requirements below before proceeding to the Readiness Test:

- Development of feed handler in accordance with OMD Interface Specification
- Successful testing of the feed handler with OMD onboarding tools
- Connection to the End-to-End Open Test Environment according to the OMD Connectivity Guide

3 Testing Approach & Readiness Policy

The Readiness Test is a “self-test” in the sense that Clients will be provided with an Answer Book of expected results of all test cases for them to verify if their feed handlers can interpret the OMD messages correctly and handle the technical features of OMD properly.

Basically, the scope of the test in Chapter 6 is applicable to clients of all OMD datafeed products unless otherwise specified.

Clients must participate in all test sessions in the Readiness Test unless specified otherwise and achieve positive results. After successful completion of the Readiness Test, Clients are required to declare their readiness by submitting a Readiness Test Result Declaration Form (“the Declaration Form”) with authorized signature. A sample of the Declaration Form can be found in Appendix A.

If a Client fails to obtain any of the expected results in the Readiness Test, the Client should re-test their feed handler in the open test environment before requesting another test slot to re-conduct the Readiness Test.

4 Readiness of Indirect Connection Clients

Clients who are providing OMD feeds in OMD original format to the indirect connection OMD Clients are required to ensure the readiness of such indirect connection Clients by providing the proper OMD environment to them to complete all Readiness Test scenarios as indicated in this document.

5 Test Arrangement and Procedure

In general, during the Readiness Test a stream of OMD multicast messages will be sent over a number of multicast channels same as the production setting as detailed in the OMD Connectivity Guide for Securities Market and Index Datafeed Products (“the Connectivity Guide”).

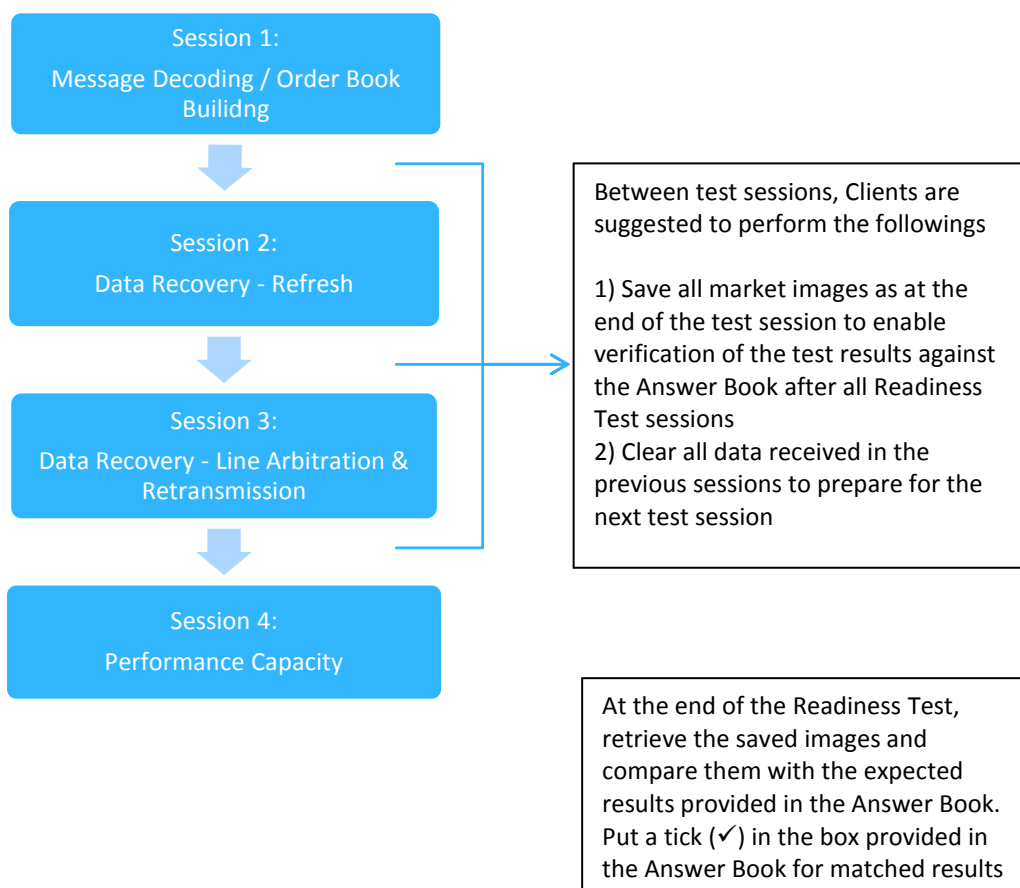
The Readiness Test will be conducted according to a test time table which covers all trading sessions in a normal full trading day or a normal half trading day. There may be exceptions for some technical test conditions where a special half trading day timetable will be used. The actual test time tables with time set for each trading session status will be provided to the participants of the Readiness Test in due course. Clients are required to conduct the Readiness Test according to the test time table.

The Readiness Test will normally be completed in a half day. There will be 5 test sessions arranged in the Readiness Test to cover the 5 test scopes as stated below. Clients will need to restart their applications, or clear the cached data between test sessions, as different data sets will be used for different sessions.

Before the commencement of the Readiness Test, HKEx will distribute an Answer Book to the Clients which covers details of messages and conditions to be checked in the 5 Readiness Test sessions and the expected results. By comparing the test results with the HKEx provided expected answers, Clients can verify their systems’ readiness to proceed to the next on-boarding stage – OMD Market Rehearsal and declare to HKEx their successful completion of the Readiness Test should their results match the expected results in the Answer Book without discrepancies.

The diagram below illustrates the flow in the Readiness Test (test sessions 1 to 4 only)

Functional Readiness Test Flow Diagram



6 Scope of Test

The Readiness Test covers test cases in the following 5 areas:

Test Area	Objectives	Test Conditions																			
1. Message Decoding & Order Book Building	All data messages specified in the OMD Interface Specification will be transmitted to enable Clients to ensure their correct interpretation of each data field received from the OMD datafeed.	Section 7.1 1 – 2																			
	Data messages resulting from various trading activities will be transmitted to enable Clients to verify the logic in their application for constructing the market depth info below: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Market Depth Information</th> <th colspan="3" style="text-align: left;">Applicable to Clients*</th> </tr> </thead> <tbody> <tr> <td>Aggregate Order Book</td> <td>● SS</td> <td>● SP</td> <td></td> </tr> <tr> <td>Full Order Book – Board Lot</td> <td></td> <td></td> <td>● SF</td> </tr> <tr> <td>Full Order Book – Odd Lot</td> <td>○ SS</td> <td>○ SP</td> <td>○ SF</td> </tr> <tr> <td>Broker Queue</td> <td>● SS</td> <td>◇ SP</td> <td>◇ SF</td> </tr> </tbody> </table> <p>* Notes</p> <ul style="list-style-type: none"> SS Securities Standard SP Securities Premium SF Securities FullTick ● All Clients of the datafeed specified ○ Clients planning to receive complementary Odd Lot Order ◇ Clients planning to receive complementary Conflated Broker Queue 	Market Depth Information	Applicable to Clients*			Aggregate Order Book	● SS	● SP		Full Order Book – Board Lot			● SF	Full Order Book – Odd Lot	○ SS	○ SP	○ SF	Broker Queue	● SS	◇ SP	◇ SF
Market Depth Information	Applicable to Clients*																				
Aggregate Order Book	● SS	● SP																			
Full Order Book – Board Lot			● SF																		
Full Order Book – Odd Lot	○ SS	○ SP	○ SF																		
Broker Queue	● SS	◇ SP	◇ SF																		
2. Data Recovery (Refresh)	Simulation of various data loss scenarios to enable Clients to verify the ability of their feed handler to recover lost data by Refresh ¹ .	Section 7.2 3.3 – 3.4																			
3. Data Recovery (Line Arbitration & Retransmission)	Simulation of various data loss scenarios to enable Clients to verify the ability of their feed handler to recover lost data by the following methods: a. Line Arbitration ² b. Retransmission ^{1,3}	Section 7.2 3.1 - 3.2 4																			
4. Performance / Capacity	Transmission of high volume data to enable Clients to ensure the ability of their feed handler to meet the capacity requirements.	Section 7.2 5.1																			
5. Failover / Disaster Recovery	Simulation of the following exceptional scenarios to enable Clients to verify the built-in processes in their feed handlers for such scenarios: a. Failover of OMD real-time data publisher b. Failover of Refresh service c. Failover of Retransmission service d. Sequence Reset again before market open e. Failover to the Disaster Recovery (DR) site	Section 7.2 6.1 6.2 6.5 6.3 6.4																			

¹ Certain exception situations on the Clients side that may require refresh or retransmission from OMD such as late connection to OMD, application restart, client network failure, etc. are not expected to be conducted during the Readiness Test, Clients need to simulate the scenarios during the End-to-End Open Test environment.

² Line Arbitration is mandatory to all feed providing vendors only.

³ Clients are required to test their processing of negative logon response and negative retransmission response during the End-to-End Open Test environment which includes i) duplicated logon, ii) logon with invalid username, iii) retransmission request – invalid / unauthorized channel ID, iv) retransmission request – message range exceeding maximum OMD cached messages, v) retransmission request – message range exceeding maximum sequence range, and vi) retransmission request – exceeding daily retransmission request limit. Various retransmission request limits will be set to a sufficient small value to facilitate the Clients to test their capability in processing negative response from OMD.

7 Test Conditions

This section lists out the conditions to be covered in both functional and technical aspects. A Client should ensure that its system meets all of the test conditions before participating in the Readiness Test.

7.1 Functional Tests

Test Condition	Details	IS* Reference
1	<u>Handling of Control Messages</u>	
1.1	Heartbeat messages in all multicast channels in Line A and/or Line B <i>Expected result:</i> Clients should be able to check system/line healthiness by Heartbeat messages	Control Messages (3.4.1)
1.2	Sequence Reset messages in all multicast channels at Start of Day <i>Expected result:</i> Upon receipt of Sequence Reset messages, Clients should clear all cached data, subscribe to the refresh channels for current market state then process (cached) real-time messages.	Control Messages (3.4.2)
2	<u>Handling of Market Data Messages</u>	
2.1	Market Definition messages covering all markets	Reference Data (3.7.1)
2.2	Security Definition messages covering (i) all available <u>InstrumentType</u> (ii) 0, 1 & 20 <u>NoUnderlyingSecurities</u> (iii) securities in all markets (iv) securities with non-blank <u>FreeText</u>	Reference Data (3.7.2)
2.3	Liquidity Provider messages with at least one with <u>NoLiquidityProviders</u> set to each of 1 & 50	Reference Data (3.7.3)
2.4	Currency Rate messages covering all currencies currently available in HKEx Securities Market	Reference Data (3.7.4)
2.5	Trading Session Status messages covering the full range of values in <u>TradingSessionSubID</u> , <u>TradingSesStatus</u> & <u>TradingSesControlFlag</u>	Status Data (3.8.1)
2.6	Security Status messages will be sent with <u>SecurityTradingStatus</u> set to 2 (Trading Halt) & 3 (Resume) at Start of Day and Intraday	Status Data (3.8.2)

Test Condition	Details	IS* Reference
2.7	<p>A series of book messages covering all possible book operations for <u>Bid/Offer</u> orders during various trading sessions in a normal trading day</p> <p><i>Aggregate Order Book Update</i> messages covering all possible aggregate book management operations</p> <p><i>Broker Queue</i> messages covering empty broker queue, broker queues with more than 1 spread broker information, broker queues with exactly 40 entries and broker queues with more than 40 entries in the book</p>	Order Book Data (3.9)
2.8	<i>Trade</i> messages covering different <u>TrdType</u>	Trade & Price Data (3.10.1)
2.9	<i>Trade Cancel</i> message will be sent. This will generate a new trade ticker that should also be processed	Trade & Price Data (3.10.2)
2.10	<i>Trade Ticker</i> messages covering different <u>TrdType</u> and at least one of the messages with <u>TrdCancelFlag</u> set on and non-zero <u>AggregateQuantity</u> to set example for partial ticker cancel	Trade & Price Data (3.10.3)
2.11	<i>Closing Price</i> messages covering majority non-zero closing price and a few zero closing price (for new securities without order/trade activities)	Trade & Price Data (3.10.4)
2.12	<i>Nominal Price</i> messages covering majority non-zero nominal price and a few zero nominal price (for new securities without order/trade activities)	Trade & Price Data (3.10.5)
2.13	<i>Indicative Equilibrium Price</i> messages covering that during Auction Session (majority non-zero and some zero IEP) and after Auction Matching (all zero IEP)	Trade & Price Data (3.10.6)
2.14	<i>Statistics</i> messages covering both shortsell and non-shortsell securities and securities with some of the statistics data unavailable, e.g. <u>HighPrice</u> , <u>LowPrice</u> , <u>Turnover</u> , <u>SharesTraded</u> , <u>LastPrice</u> if no order/trades activities for the securities	Value Added Data (3.11.1)
2.15	<i>Market Turnover</i> message covering all markets and all available currencies available in HKEx Securities Market	Value Added Data (3.11.2)
2.16	<i>Yield</i> messages covering non-zero <u>Yield</u> and zero <u>Yield</u> (i.e. yield is not available)	Value Added Data (3.11.3)
2.17	<i>News</i> messages covering multiple segmented news and news with zero and maximum values for <u>NoSecurityCodes</u> , <u>NoMarketCodes</u> and <u>NoNewsLines</u>	News (3.12.1)
2.18	<i>Index Definition</i> messages covering all indexes offered in OMD Index datafeed product	Index Data (3.13.1)

Test Condition	Details	IS* Reference
2.19	<p data-bbox="491 174 1182 264"><i>Index Data</i> messages covering all indexes offered in OMD Index with some of the messages with Null and/or populated values for some of the fields</p> <p data-bbox="491 304 1182 524"><u><i>Expected Result for Test Conditions 2.1 – 2.19:</i></u> <i>Clients are able to extract the market data messages encapsulated in the multicast packets and to decode the messages according to the OMD Interface Specifications for display and/or further processing. The final image of specific securities/indexes/news should match perfectly the expected results provided in the Answer Book.</i></p> <p data-bbox="491 564 1182 748"><i>Clients are able to build the correct aggregate order book, full board lot order book, full odd lot order book and conflated broker queue comprising spread and broker information. The final book and broker queue image of specific securities should match perfectly the expected results provided in the Answer Book.</i></p>	Index Data (3.13.2)

7.2 Technical Tests

Test Condition	Details	IS* Reference
3	<u>Data Recovery</u>	
3.1	A gap will be introduced in Line A and/or Line B for the client to detect <i>Expected Result:</i> <i>Clients are able to detect the gap in Line A and/or Line B.</i>	Gap Detection (4.1)
3.2	A gap will be introduced in a single line, either Line A or Line B. Client detects missing packets in one line and to process the packet from the other line, in other words, Client arbitrates and merges the duplicated contents received in Line A and Line B for subsequent processing <i>Expected Result:</i> <i>Clients are able to merge the duplicated messages from Line A and Line B for different sets of dual multicast channels for subsequent message decoding and processing and able to detect gaps in the multicast packets received. From there the Clients can arbitrate the two lines to fill in any gaps detected in any one of the two lines.</i>	Line Arbitration (4.2)
3.3	A large gap will be introduced to both Line A and Line B expecting the Client to request the latest market state images from the refresh service <i>Expected Result:</i> <i>Clients are able to join the refresh channel and recover the latest market image up to the current point whilst processing real-time market data.</i>	Refresh (3.6.1, 4.4)
3.4	Client correctly processes the <i>Refresh Complete</i> message and applies it to their current cache of market data. <i>Expected Result:</i> <i>The final image of specific securities/indexes should match perfectly the expected results provided in the Answer Book.</i>	Refresh (3.6.1, 4.4)
4	<u>Retransmission Service</u>	
4.1	<i>Heartbeat</i> messages in retransmission service	Control Messages (3.4.1)
4.2	Client sends <i>Logon</i> message with valid username expecting OMD to respond with a <i>Logon Response</i> message with <u>SessionStatus</u> set to 0 (Session Active)	Retransmission (3.5.1, 4.3)
4.3	Client processes <i>Logon Response</i> message	Retransmission (3.5.2, 4.3)

Test Condition	Details	IS* Reference
<p>4.4</p> <p>4.5</p> <p>4.6</p>	<p>Test the reception of positive <i>Retransmission Response</i>:</p> <p>Client sends <i>Retransmission Request</i> message with valid channel ID and valid <u>BeginSeqNum</u> / <u>EndSeqNum</u> fields expecting OMD accepts its request with <i>Retransmission Response</i> set to 0 (Request accepted) <u>RetransStatus</u> if the messages requested will not exceed any retransmission system limits as stated in the OMD Interface Specifications</p> <p>Client processes <i>Retransmission Response</i> message.</p> <p>Client processes the requested lost messages in unicast transmission following receipt of a positive <i>Retransmission Response</i> message and can fill in the gap detected in real-time multicast channels for the subsequent processing</p> <p><u>Expected Result for Test Conditions 4.1 – 4.6:</u> <i>Clients are able to detect missing packets, which contain trades or trade tickers, and are able to recover the missing messages from the retransmission server for continuation of real-time market data processing.</i></p> <p><i>The full trade and/or full trade tickers of specific securities/indexes should match perfectly the expected results provided in the Answer Book.</i></p>	<p>Retransmission (3.5.3, 4.3)</p> <p>Retransmission (3.5.4, 4.3)</p> <p>Retransmission (3.5.4, 4.3)</p>
<p>5</p> <p>5.1</p>	<p><u>Performance / Capacity</u></p> <p>Market Data will be disseminated at increasing rates on all OMD datafeed products. Clients are expected to receive market data volume at a rate that will drive to the peak bandwidth requirements for each datafeed product.</p> <ol style="list-style-type: none"> 1. 50% of maximum 2. 100% of maximum <p>Clients must handle all rates without dropping data. The Answer Book will provide the Sequence Number of the last message. Clients should check their last Sequence Number that they receive against the provided number and make sure that there is no gap in the Sequence Number of messages received.</p> <p><u>Expected Result:</u> <i>Clients are able to handle full capacity for all of their subscribed OMD datafeed products in the same set of SDNet/2 or HSN circuits without losing multicast data, which is a symptom of an overloaded link in a chain. The last Sequence Number received in each channel should be identical to the Sequence Number provided in this Answer Book. Also the full trade and/or full trade tickers of specific securities/indexes should match perfectly the expected results provided in the Answer Book.</i></p>	<p>N/A Performance Testing</p>

Test Condition	Details	IS* Reference
6	<u>Failover / Disaster Recovery</u>	
6.1	<p>Failover of real-time Publisher process</p> <p><u>Expected Result:</u> <i>Clients are able to handle Publisher failover without experiencing any interruption and can continue to receive real-time market data after the failover.</i></p> <p><i>The final image of specific securities/indexes, in particular for SS Clients the aggregate order book and trade tickers of specific securities should match perfectly the expected results provided in the Answer Book.</i></p>	Error Recovery (2.2.4.1)
6.2	<p>Failover of Refresh Service process</p> <p><u>Expected Result:</u> <i>Clients will receive a Sequence Reset (100) message in each of the refresh channels after Refresh Service process (RFS) failover if they're subscribing to the refresh channels. Clients are expected to handle RFS failover properly without affecting the reception of real-time market data and can capture a full latest market image from RFS for their processing.</i></p> <p><i>The final image of specific securities/indexes should match perfectly the expected results provided in the Answer Book.</i></p>	Error Recovery (2.2.4.1)
6.3	<p>Sending second sets of Sequence Reset messages in real-time multicast channels before market open</p> <p><u>Expected Result:</u> <i>Clients will receive a Sequence Reset (100) message in each of the channels they subscribed before market open. Clients should be able to replace the previously received securities information by the correct one received after the reception of this Sequence Reset (100). The final image of specific securities for the reference data should match perfectly the expected results provided in the Answer Book.</i></p>	Control Message (3.4.2)
6.4	<p>OMD simulates DR site failover</p> <p><u>Expected Result:</u> <i>Clients are able to handle DR site failover gracefully including the handling of Sequence Reset messages, recovery from refresh service and merging of refresh image into real-time market data. The final image of specific securities/indexes, should match perfectly the expected results provided in the Answer Book.</i></p>	Error Recovery (2.2.4.2)

Test Condition	Details	IS* Reference
6.5	<p>Primary Retransmission server will be stopped and only the secondary server remains operational. Clients are required to connect to the secondary and make retransmission requests.⁴</p> <p><i>Expected Result:</i> <i>Clients are able to detect failure of Retransmission Server (RTS) A and auto-switch to reconnect to RTS B for the recovery of missing packets. The final image of specific securities/indexes should match perfectly the expected results provided in the Answer Book.</i></p>	Retransmission (3.5.3, 4.3)

* IS refers to OMD Interface Specifications for Securities Market & Index Datafeed Products – Binary Protocol (version 1.2)

⁴ HKEx will set the limit on "Maximum Number of Request per Day" to a sufficient small value (i.e. 10 as planned) in the Secondary Retransmission server during this test session to set the test conditions for the Clients to test their capability of processing negative retransmission response for exceeding daily retransmission request limit, Clients are required to make 10+ retransmission requests when connecting to the Secondary Retransmission server to verify that they can process negative response from OMD correctly.

Appendix A – OMD Readiness Test Result Declaration Form (Sample)

To: HKEx-IS – Market Data Department

Email: IVSupport@hkex.com.hk

All Real-time direct connection clients are required to return this form by email to HKEx-IS **on or before xx xxx 2013**

I hereby on behalf of <Company Name> (“the Company”) declare that the Company has successfully completed the Readiness Test on <date> for the OMD datafeed products specified in Section A.1 below and the test results as detailed in Section A.2 are true and correct.

A.1 Please check the OMD datafeed products covered in this Declaration Form

- | | |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------|
| <input type="checkbox"/> Securities Standard (SS, including Conflated Broker Queue) | <input type="checkbox"/> Index Feed (Index) - Optional |
| <input type="checkbox"/> Securities Premium (SP) | <input type="checkbox"/> Odd Lot Order (OLO) - Optional |
| <input type="checkbox"/> Securities FullTick (SF) | <input type="checkbox"/> Conflated Broker Queue (CBQ) - Optional |

A.2 Test Results Declared

Test Session	Test Results <i>(please check applicable items)</i>
1. Message Decoding & Order Book Building	<input type="checkbox"/> All data fields in all messages are correctly interpreted and match the expected values provided in the Answer Book <input type="checkbox"/> All Aggregate Order Book (10 best bid/offers) are correctly built with all updates matching the expected results provided in the Answer Book <input type="checkbox"/> Full Board Lot Order Book are correctly built with all updates matching the expected results provided in the Answer Book <input type="checkbox"/> Full Odd Lot Order Book are correctly built with all updates matching the expected results provided in the Answer Book <input type="checkbox"/> Broker Queue are correctly built with all updates matching the expected results provided in the Answer Book
2. Data Recovery (Refresh)	<input type="checkbox"/> Latest market images are successfully obtained from Refresh service with all data fields matching the expected values provided in the Answer Book
3. Data Recovery (Line Arbitration and Retransmission)	<input type="checkbox"/> Lost data are successfully recovered from line arbitration and/or retransmission and the recovered data match the expected values provided in the Answer Book <input type="checkbox"/> Exceptions in Retransmission are handled properly with results same as those stated in the Answer Book <input type="checkbox"/> We have tested our system on its ability to handle all possible status codes returned from the Retransmission server in response to our request and we are satisfied with the test results
4. Performance / Capacity	<input type="checkbox"/> Our feed handler can handle the peak traffic installed for the datafeed products checked in Section A.1 without any data loss
5. Failover / Disaster Recovery / Exception Handling	<input type="checkbox"/> Our feed handler can handle the failover scenarios covered in the Readiness Test with all data field values remaining intact and identical to expected values provided in the Answer Book <input type="checkbox"/> The operation of switching our feed handler to the DR site is smooth with all data fields remaining intact and identical to expected values provided in the Answer Book <input type="checkbox"/> We have tested our system on its ability to reflect the latest market snapshot in time in the event of late connection or reconnection to OMD and we are satisfied with the test results

A.3 Authorized Signature

Company Name : _____

Name of Authorized Person : _____ Title : _____

Signature : _____ Date : _____