**NEPTUNE Canada**

**Instrument Quality Requirements**

**Stage I Observing Systems**

**(Instrument and Instrument Support Equipment)**

Issue 1.8

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NEPTUNE Canada

# Document Control Sheet

Contact for Revisions and Proposed Changes

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**Revisions**

| Issue | Date | Document Status |
|---|---|---|
| 1.0 | 7-Nov-05 | Draft for review prior to instrument workshop. |
| 1.1 | 8 nov 05 | Comments by Chris Barnes |
| 1.2 | 9 Nov 05 | Additional comments after Hydrates I workshop |
| 1.3 | 15 Nov 2005 | Test Section 7 edited. Other additions. |
| 1.4 | Nov 18 | Instrument specification outline. |
| 1.5 | Jan 24, 2006 | Reviewed and edited. |
| 1.6 | February 2, 2006 | Simplified requirements. |
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# Table of Contents

# 1. NEPTUNE Canada Quality Requirements

## 1.1. Purpose

This plan defines the quality related activities and requirements to be fulfilled during the development and procurement of instruments for NEPTUNE Canada (NC).

## 1.2. Scope

This plan covers quality related activities associated with:

1. Commercial off-the-shelf (COTS) instruments and equipment
2. Non-COTS instruments equipment
3. Design and development of instruments
4. Instrument fabrication and manufacturing
5. Inspection and test of Instruments
6. Handling and shipping
7. Instrument installation
8. Calibration, corrosion, biofouling and long-term deployment issues
9. Instrument communications system
10. Extensions from an access point on the infrastructure to an instrument or instrument package.
11. Interface adapters in instrument packages.
12. Instruments/vehicles requiring significant development and needed by multiple users such as Vertical Profiling Systems (VPS), Autonomous Underwater Vehicles (AUVs.), node based ROVs, Crawlers and rail vehicles.
13. Bottom structures and instrument frames

# 2. Quality Plans

Work undertaken under each agreement with NC must be undertaken in accordance with an approved Quality Plan developed in concert with NC. The Quality Plan shall be incorporated as a deliverable document in the first milestone of the agreement.

## 2.1. Quality plan content:

Quality plans shall include a table of all quality related activities specific to each instrument in each proposal.

Activities that must be considered are described in this document as a basis for a quality planning although once considered it should be agreed between NC and the PI whether or not the activity is required.

There may be other activities not described herein that should be considered.

## 2.2. Instrument Qualification Plan

Instruments requiring development prior to qualification for long term deployment on NEPTUNE Stage 1 will be developed to an agreed qualification plan. There will be a payment milestone for instrument qualification.

The qualification of an instrument means completing an agreed inspection and test plan and demonstration. It should include supporting analysis for parameters which cannot be easily tested such as corrosion resistance.

The goal of the qualification is to demonstrate compatibility to the observatory including:

- Power interference (peak currents, transient generation )
- Immunity to maximum specified power noise on the observatory.
- Power consumption
- Long term deployment factors including biofouling and corrosion
- Calibration with a known measure of data confidence
- Data format consistent with DMAS requirements
- Verification of instrument control
- Support or NEPTUNE security requirements
- Physical manageability –ability to install and retrieve
- Environmental impact

## 2.3. Quality Verification

NC intends to inspect manufacturing when appropriate to verify conformance to these requirements. Early inspections of manufacturing processes will be performed in addition to final acceptance inspections prior to deployment.

NC will make available clear acceptance standards.

Inspections will be scheduled with the interested parties with sufficient advanced notice.

Instruments will be inspected against specified acceptance standards prior to closing or sealing for deployment.

Where problems or non-conformances to standards are found they will be noted and discussed with the parties involved.

NC reserves the right to refuse acceptance for deployment.

Decisions on re-work or other action will be the responsibility of the Principal Investigator but should be made in agreement with NC.

The repaired or re-worked instrument shall meet the original acceptance requirements unless agreed between the PI and NC.

## 2.4. Testing and Commissioning

No equipment will be approved for installation without satisfactory completion of an agreed test plan including qualification, acceptance testing and commissioning activities.

NC reserve the right to be present for critical tests during the course of the development and at final acceptance tests. Notification of such tests shall be provided with adequate advance notice and should be according to the agreed test plan. Refer to section

## 2.5. Software development

Any software development shall be performed according to an software development plan to be submitted with the quality plan.

# 3. Instrument Qualification

## 3.1. Design Requirements

This section describes instrument development requirements. It does not address specific measurement methods or the suitability of an instrument to measure any parameter.

### 3.1.1. Thermal Analysis

A thermal analysis shall be provided for all enclosures. Estimates of the power dissipation and surface area should be considered before doing a detailed analysis.

Instruments should not be deployed if any components will be operating beyond the manufacturer's specifications.

### 3.1.2. Critical Implodable Volumes Potentially in the Vicinity Of Manned Submersibles.

Where pressure vessels can reasonably be expected to be in the vicinity manned submersibles they shall be designed and tested to withstand 1.5 times the operating pressure and shall meet the intent of US NAVY Standard **NAVSEA** SS800-AG-MAN-010/P-**9290** - *System Certification Procedures and Criteria Manual for Deep Submergence Systems* with respect to critical implodable volumes. The standard allows design analysis where pressure testing is impractical.

### 3.1.3. All Pressure Vessels

Pressure vessels shall be designed to withstand 1.5 the operating pressure. Proof of design can be through one-off pressure test or design analysis. Where the pressure vessel has not been qualified according to NAVSEA 9290 it shall be labelled and documented with the calculated standoff distance so that manned submersibles may keep clear.

### 3.1.4. Seal standards (O-rings, others)

O-ring surfaces, grooves and O-ring specification shall be according to recognized industry and the recommended seal manufacturer's specifications.

Where possible seals shall be designed to capture the O-ring so there is no possibility of the O-ring being displaced during the closing operation.

Seals not relying on O-rings shall be qualified based on records of use in similar situations (depth and materials) and applicable industry standards.

Where practical pressure vessels should be designed to allow seal integrity tests. e.g. pressure ports between dual o-rings or vacuum ports. Refer: 6.5.3

# 4. Manufacturing for deployable instruments

## 4.1. Documentation

All deployable instruments shall be manufactured to controlled schematics, mechanical drawings, work instructions.

Test procedures shall be included in the manufacturing documents. Refer: 6.1 Test Plans

The documents will be deliverable prior to start of manufacturing.

As-built documentation including all changes shall accompany the deliverable instruments.

## 4.2. IPC-A-610D Acceptability of Electronic Assemblies

Electronic assemblies will be inspected against the applicable sections IPC-A-610D Acceptability of Electronic Assemblies. NC will endeavour to inform the PI's of the applicable sections as this standard covers the whole spectrum of electronics manufacturing.

## 4.3. Electro Static Discharge (ESD)

Ref: *IPC-A-610D Section 3 Handling Electronic Devices Table 3.4 Recommended Practices for Handling Electronic Assemblies*.

Technicians handling ESD sensitive instruments shall be trained in ESD prevention.

ESD protective devices shall be used and worn where appropriate consistent with the level of susceptibility to ESD damage.

## 4.4. Requirements for Soldered Electrical & Electronic Assemblies

Electrical and electronic assemblies should be manufactured according to the inspection standards identified in J-STD-001D *Requirements for Soldered Electrical & Electronic Assemblies*.

All soldering equipment and persons performing soldering shall be qualified accordingly.

## 4.5. Wire routing and strain relief of conductors

Wired assemblies will be inspected against applicable sections of IPC-A-610 Acceptability of Electronic Assemblies. Emphasis will be placed on wire strain relief, minimum bend radii, protection from wire entrapment in seals and wire crushing and pinching in fastened assemblies.

## 4.6. Circuit board hardware, attachment physical shock limits

Circuit boards shall be fixed to chassis with purpose built standoffs and mounting hardware. Shock absorbing mounts will be used according to manufacturer's specifications and according to the designers specifications if applicable.

## 4.7. Electrical isolation of circuits and pressure vessels

Consideration shall be made for the isolation of the pressure vessel electrical systems.

Where isolation is required it shall be noted in work instructions and test procedures.

Tests shall be performed to verify the electrical isolation. These tests shall not subject electronics to damaging voltages or currents in the event of test failure.

## 4.8. Shielding of circuits and conductors including connectors

When shielding is applicable the assembly instructions shall be clear as to the connections required and those that are not to be made. The instructions shall indicate test points and acceptable measured values.

## 4.9. Fibre Handling

### 4.9.1. Fibre Bend limits

Minimum specified bend radii shall be observed.

Fibre management trays and spools are too be used whenever possible. If there is room for a spool or tray it must be installed. Fibre management which has the *potential* to cause fibre stress will be rejected regardless of the current condition.

### 4.9.2. Fibre Splice standards

Where practical and where an assembly will be flooded, fusion splices shall be used to connect fibres.

In line connectors can be used if:

1. There is adequate margin in the optical budget to accommodate the worst case specification of the connector type
2. The volume is not to be flooded with fluid which is optically opaque at the transmission wavelength.

### 4.9.3. Fibre Cleaning

Fibre connectors are to be cleaned according to industry standard procedures.

Refer to fibre equipment manufacturers for examples of reasonable procedures.

Fibre scopes shall be used to verify cleaning.

## 4.10. Seals and O-ring handling

### 4.10.1. Seal Inspection

All seals are to be visually inspected prior to assembly.

O-rings are to be replaced with new o-rings upon failed inspections.

O-rings should not be replaced unnecessarily.

### 4.10.2. Seal Lubricant

Seals are to be lubricated according to the manufacturers instructions with attention paid to quantity and type of lubricant.

### 4.10.3. Pressure Vessel Closing

Pressure vessel design should be such that special tools or operator training should not be required for proper sealing.

If special orientation is required prior to closing it shall be clearly marked.

Seals shall be verified by:

- Helium leak tester,
- Vacuum ports
- Pressure testing

- Other means described in the Instrument documentation and agreed with NC.

Once seals are verified the pressure vessel shall remain unopened prior to deployment.

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### 4.11. Cable Moulding Standards (Chemical Bond, Mechanical Seals And Glands)

For cable terminations using moulded parts relying on chemical bonds between the cable outer jacket and the moulding material:

- The moulding process shall be qualified based on chemical analysis and use history and tests performed.
- Test mouldings shall be made using cable samples from the deployable cable (prior to termination) and applicable potting material from the same batch as the deployable termination.
- Adhesion tests shall be performed on the test mouldings to verify the bond integrity.
- Test records and samples shall be maintained.

## 5. Handling *and shipping*

### 5.1. ESD protection

Appropriate packaging shall be used for electronic assemblies.

If an instrument is sensitive to ESD it shall be noted on the outside of the shipping container.

### 5.2. Packing and shock protection

Instruments shall be packed in purpose built cases and fixed in position.

Loose packing such as bubble wrap and popcorn foam which does not fix the instrument in place should not be used.

Crates and packing shall be reusable to allow shipment back to the supplier or institution for servicing upon retrieval.

### 5.3. Shock recording

Where an instrument is sensitive to physical shock (criteria to be agreed with NC):

1. the maximum allowable shock to the instrument shall be specified and clearly marked.
2. shock recording devices shall be employed to demonstrate that an instrument has not experienced a shock beyond specification during shipment or at any time prior to deployment including transits on board installation vessels. NC will provide the shock recorders if required.
3. When shock recorders indicate the instrument has experienced an excessive shock it shall not be deployed until it has been verified as undamaged. The investigation shall include a thorough inspection including redoing relevant portions of the acceptance tests and verifying calibration.
4. The cause of the high recording shall be investigated and preventive measure taken to avoid recurrence.

5. Carts, dollies or other PI supplied handling equipment should be sufficiently stable to prevent toppling.

### 5.4. Connector protection

All connectors shall be covered and protected when not in use. They shall be specifically protected from all contaminants (liquids and particles), damage from drops and inadvertent handling of the contacts.

Plastic or metal caps shall be available to fit all connectors.

The contacts shall be protected to prevent damage to the instrument by ESD through the connector.

Connectors shall not be mated and de-mated unnecessarily.

### 5.5. Cable protection

All cables shall be packed and handled to prevent bending beyond the minimum bend radius. When working with cables the minimum bend radius shall be clearly identified in the work area and known. Cables that have exceeded the minimum bend radius shall be inspected for damage and the inspection noted in the maintenance logs.

Cables shall protected from being trod upon or run over with equipment.

## 6. Testing

### 6.1. Test Plan:

The PI is responsible for developing an instrument test plan which should include for each instrument:

1. Instrument under test
2. parameters to be tested
3. Pass/fail criteria (qualitative only) for each test
4. Schedule of tests relative to qualification milestone including submission of draft and final procedures. i.e. The draft schedule should say when the test procedures will be submitted (see ‘Test Procedures’ below).

### 6.2. Test Procedures

Test procedures shall be produced by the proposal group. They will be reviewed by the NC and by other interested parties.

Detailed test procedures shall be available for review with sufficient time to incorporate changes.

Test procedures shall be consistent with the test plan and include:

1. Instrument under test
2. Parameters to be tested
3. Pass/fail criteria in detail
4. List of test instruments required
5. List of equipment required

6. Instructions at a suitable level consistent with qualifications required to operate the test equipment. (assume qualified operators)
7. Blank test record

Where measurements are for reference to determine instrument trends for calibration or to check degradation (with no pass/fail criteria) they shall be noted in the procedure.

## 6.3. Calibration Of Test Instruments

Test Instruments shall be within calibration during the test. The test records should allow space to document the Instrument ID and calibration dates.

## 6.4. Verification Of Prerequisite Component Tests

Where individual circuits are to be tested prior to assembly the tests should be documented and the test records should be included with the final test records.

## 6.5. Final Acceptance Testing at NEPTUNE Canada facilities –

### 6.5.1. Power

Power compatibility will be verified by bench test prior to deployment. Emphasis will be placed on testing early to prevent delays closer to deployment.

### 6.5.2. Data

Communication will be validated. The instrument may be connected to a dry NEPTUNE interface to verify compatibility prior to deployment. All DMAS requirements will be checked.

### 6.5.3. Leak Test Prior to Deployment

Once closed for deployment pressure vessel seals shall be tested to verify integrity. Submerged pressure testing is not desirable due to the risk of flooding the vessel during the test. Vacuum ports and helium leak testing should be considered.

The pressure vessel shall be tagged or marked to indicate whether or not the seals have been verified.

## 6.6. Bench test

As applicable for a bench test. Where it is not possible to test a particular parameter in the bench test it should be noted and consideration should be given to these in subsequent tests.

The bench test will be comprised of communication and power testing to ensure compatibility with the network. Details to be included in the test procedure and should include at least the following:

1. Instrument operates when connected to power
2. Instrument operates when power is interrupted and re-established
3. Instrument power consumption is as specified
4. Bi-directional communication as specified
5. Communication re-established after power interruption
6. Communication re-established after communication interruption

Potentially damaging tests such as transient response will not be tested on deployable instruments unless agreed. The PI should provide sufficient details and specifications of the power supply protection.

### 6.7. Ocean test

Instruments may undergo an ocean test on the VENUS system if deemed beneficial. Commercial instruments may be pre-qualified and not require ocean testing on Venus. This test will not be valid as a substitute for any pressure tests as the VENUS node is in relatively shallow water. The ocean testing will provide a final check of instrument compatibility with the network and serve a trial run for the deployment and recovery procedures.

## 7. Operation and Maintenance

### 7.1. Manual

An Operation Manual shall be supplied with the as-built documentation upon delivery of the instrument including:

1. Start-up procedure
2. Initialization routine
3. Orientation during operation
4. Temperature concerns
5. Submersion requirement during operation
6. Shut-down procedure

### 7.2. Deployment and recovery instructions

1. Sequence of operations during deployment
2. Distance between or arrangement of sensing elements
3. Platform anchoring, levelling, and stabilising
4. Sequence of operations during recovery

### 7.3. Maintenance instructions

1. Frequency
2. Cleaning
3. Disassembly/reassembly
4. O-ring replacement
5. Nitrogen flushing
6. Oil filling
7. Calibration instructions

# 8. Rework, Repair and Observatory Redeployment

## 8.1. Disposition of Failed Instrument

NC working in agreement with the PI will determine if an instrument may be repaired and redeployed.

## 8.2. Repair and Rework Standards

Instruments must meet the original standards as applied to the initial deployment in addition to any new standards deemed necessary to prevent recurrence of the failure.

## 8.3. Redeployment

Instruments which have not been changed after recovery may be redeployed without re-test.

NC will control the redeployment of instruments including determining which tests need to performed.

# 9. Serviceability

## 9.1. Allowable Field Service

The instrument supplier shall specify the extent of allowable field service the service that is required to be done at the manufacturers facility. This should be documented in the operations manual.

## 9.2. Access to electronics and special tooling availability

The instrument supplier shall provide all necessary tooling for allowable field service.

## 9.3. Training

If technicians require training to perform field service it shall be made available at NC facilities.

## 9.4. Protection during maintenance and servicing:

The same protection should be applied as before deployment. The supplier should provide guidance and equipment for the following:

1. Handling and mounting frames, cart and dollies
2. Identification of ESD sensitive parts
3. Covers for seal surfaces if practical and instructions for unusual seal types.
4. Cable harness strain relief while in the instrument is open
5. Connector protection (cover and caps)
6. Special environmental restrictions with respect to humidity and temperature and particulate contaminants.