



SCUBA-2 Canadian Project Office
 University of British Columbia
 Department of Physics and Astronomy
 6224 Agricultural Rd.
 Vancouver, B.C.
 CANADA
 V6T 1Z1

Tel: 1-604-822-1938
 Fax: 1-604-822-6709
 Email: jmolnar@physics.ubc.ca

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Document Prepared By:	Janos Molnar SCUBA-2 Canadian Project Mgr	Signature and Date:	2 nd , Dec. 2004
Document Approved By:	Mark Halpern MCE Project Director Pierre Bastien POL-2 Project Director David Naylor FTS-2 Project Director	Signatures and Date:	2 nd , Dec. 2004
Document Released By:	Janos Molnar Canadian Project Mgr	Signature and Date:	2 nd , Dec. 2004

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CHANGE RECORD

Issue	Date	Section affected	Change Description
0.1	01/12/04	All	New document.
0.2	02/12/04	Front page	Removed spelling error

APPLICABLE DOCUMENTS

Reference	Document Title	Document Number	Issue & Date
AD1	Canada Occupational Health and Safety Regulations http://www.oshforeveryone.org/leg/documents/canada/caeclc/caroshe0.htm		Latest version can be found on the indicated website
AD2	WCB Laboratory Safety Regulation part 30		
AD3	Quebec Occupational Health and Safety Regulations		
AD4	SCUBA-2 shall be compliant with both the Health and Safety at Work Act 1974 and UK ATC Health and Safety regulations http://intra.roe.ac.uk/atc/admin/health_safety/manual/index.html	see ROE intranet ref	Latest version can be found on the ROE intranet at the URL address stated.
AD5	JAC Health and Safety Regulations http://www.jach.hawaii.edu/JACpublic/JAC/docs/safeman/frontm.htm	see JACH internet ref	Latest version can be found on the ROE intranet at the URL address stated.

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1. INTRODUCTION

1.1 THE SCOPE OF THIS DOCUMENT

This document describes the safety issues relating to the fact that the Multichannel Electronics (MCE) of the SCUBA-2 Instrument as well as its auxiliary instruments, the Polarimeter (POL-2) and the Fourier Transform Spectrometer (FTS-2) are being designed, assembled and tested at the Physics and Astronomy Dpt. at UBC, Université de Montréal (UdeM) in Québec and University of Lethbridge (UoL) in Alberta respectively before being delivered to the James Clark Maxwell Telescope (JCMT) run by the Joint Astronomy Centre (JAC) in Hawaii. This document is regarded as a "living document" which will be developed as the SCUBA-2 Project progresses to completion and delivery of the instrument.

The document addresses the issues and risks to personnel and hardware during normal operations, maintenance, transportation, handling, and while being subjected to the environments that will be encountered during the various stages the project will go through.

1.2 THE PROJECT SAFETY POLICY

In respect of MCE and the SCUBA-2 auxiliary equipments the project team will ensure that, to the best of their ability, they will conform to all relevant notified Site Safety Requirements applicable at the UBC, UdeM, UoL and JAC. In addition, the project will ensure that SCUBA-2 conforms to good, safe, engineering practice and formal Safety Documents, where applicable. The project team will provide user operation and maintenance documentation and appropriate training to ensure that the SCUBA-2 and its auxiliary instruments can be used safely.

1.3 APPLICABLE SAFETY DOCUMENTS

- a) Canada Labour Code Part II
- b) WCB Laboratory Safety Regulations Part 30
- c) Quebec.....
- d) Alberta
- e) JAC Health and Safety Regulations:

<http://www.jach.hawaii.edu/JACpublic/JAC/docs/safeman/frontm.htm>,

Since the MCE and likely the POL-2 and FTS-2 will be tested and system integrated in the UK, we will also make sure that our design does not contradict to both the

1. UK ATC Health and Safety regulations:

http://intra.roe.ac.uk/atc/admin/health_safety/manual/index.html and the

2. UK Health and Safety at Work Act 1974

Persons nominated as having Safety Responsibilities:

- SCUBA-2 Canadian Safety document (maintenance) – Janos Molnar– SCUBA 2 Canadian Project Manager.
- UBC SCUBA-2 Safety Responsible – Mark Halpern – MCE Project Director
- UdeM SCUBA-2 Safety Responsible – Pierre Bastien – POL-2 Project Director
- UoL SCUBA-2 Safety Responsible – David Naylor – FTS-2 Project Director
- JAC SCUBA-2 Safety Responsible – Tomas Chylek / Dean Shutt

1.4 DIVISION OF RESPONSIBILITIES

This document identifies only those safety issues as they relate to the SCUBA-2 project.

A Safety Audit document will be produced that will define whether it is the respective Canadian development institutions or JAC who have responsibility for ensuring the Safety Requirements are met. In most cases the initial responsibility is with the respective institutions, and is transferred to JAC during or after commissioning the SCUBA-2 Instruments.

Since the Polarimeter, which is an auxiliary instrument to SCUBA-2 is being developed in Québec, Canada, where the official language is French, certain safety requirements, such as warning signs will have to be adhered to as long as the instrument is operated in Québec. Prior to shipping the Polarimeter to the site, those temporary signs in French will be removed.

2. ORGANISATION OF THE SCUBA-2 SAFETY DOCUMENT

This document is divided into the following sections.

Section 3. Safety Design Requirements

This section will list safety related specifications, requirements, and the method of compliance adopted during the Design Phase.

Section 4. Generalised Risk and Safety Issues on Site

Short referenced summaries of generalised issues primarily listed in Section 5, that is, at the base facility or telescope site.

Section 5. Specific Safety Areas of SCUBA-2 to be considered on Site

This section lists, but does not detail, the major areas of work that need to be considered.

Section 6. Safety Related Documentation and training

3. SAFETY DESIGN REQUIREMENTS

3.1 MECHANICAL

3.1.1 Dimensions and Standards

The SCUBA-2 instrument will be designed and manufactured using the SI system of weights and measures.

3.1.2 Structural Integrity of the Instrument

Generally the structural integrity of the instrument will be verified by means of the FEA and other analysis carried out as part of the design to be presented at major reviews i.e. PDR, CDR. The models for these will address stress and load issues and structural performance.

To reduce hysteresis, the clamping forces at joints and the number of fasteners used will exceed those needed solely for structural integrity.

Wear is not considered a factor in the design.

The SCUBA-2 requirement for a safety factor of 4 in stress levels will be met or exceeded and will also ensure the shock level requirements for the project are met.

3.1.3 Welded Joints

Structural welded joints will be stress relieved and under go non-destructive testing i.e. visually inspected or crack tested to the applicable Canadian specifications.

3.1.4 Nuts, bolts and fastening torques

For any application, nuts and bolts shall be of suitable material strength and threads selected for their specific application.

Fine threads shall be employed in high torque applications.

Thread lengths on all nuts and bolts shall be not less than $1.5 \times$ bolt diameter.

The delivered manuals shall include details of torque settings and pull-up sequences where applicable.

3.1.5 Strength of Materials

All materials shall be specified which meet:

- the (TBA) stress Safety Factors
- the specified range of environmental, shock and thermal requirements.

3.1.6 Anti Corrosion Protection Measures

Materials that are susceptible to corrosion shall be protected commensurate with their operational environmental conditions. These protection measures shall also take into account the conditions that may be encountered during shipping of the equipment and their temporary storage at both the Hawaii base facilities (high humidity) and at the JCMT site.

Mating metallic materials shall be selected to minimise the risk of bi-metal electrolytic corrosion.

Uncoated mild steel components shall be chemically degreased, shot-blasted or corrosion cleaned off prior to being primed and painted.

Aluminium components will be anodised or painted as appropriate.

Non-stainless materials or fasteners shall be appropriately protected.

Machined mounting surfaces shall be protected by a thin film of oil, or other suitable measures taken, during transit.

Painting and plating of materials shall comply with Canadian statutory requirements. Any special US or local requirements should be notified to the SCUBA-2 Canadian Project Manager.

3.1.7 Lifting Points, Handles and Balancing

SCUBA-2 MCE, POL-2 and FTS-2 are large and heavy instruments and special care shall be taken when selecting and designing the necessary lifting and slinging point arrangements.

The lifting points shall be designed such that each component weighing over 15kg have a minimum of 2 lifting points. Components weighing over 15kg are to have a 4 point lifting arrangement.

Elsewhere sub-assemblies of over 5kg weight needing to be lifted at arms length shall also be fitted with a minimum of 2 lifting points.

Each lifting point shall be designed to take 1.5 times the maximum load to be borne.

Eye bolts are to be secured using their full thread depth screwed into an appropriate mounting boss welded to the component.

Lifting points shall be located at points on the instrument or its sub-assemblies which are shown to be structurally safe, are accessible, provide practical methods of handling by hoist, and avoid serious imbalance when the component is lifted.

For components and sub-assemblies weighing less than 15kg, and where practical, lifting handles shall be fitted to provide a safe means of manual handling.

3.1.8 Sharp edges

Standard fabrication practice will be used to prevent dangers to personnel. This will include but not be confined to:

- De-burring all machined holes, fettling castings, etc.
- Chamfering edges, corners of machined metalwork.
- Fitting trim to edges of very thin panels.

3.1.9 Protection of Delicate Components

Where necessary, shields, extensions and protrusions shall be designed integral to components or sub-assemblies to prevent accidental injury or damage either to or by maintenance personnel during routine maintenance or installation handling.

To prevent damage to the delicate detector sub-arrays, the project shall provide specially manufactured enclosures for their safe transportation and storage.

To prevent damage to a detector focal plane sub-assembly, the project shall provide specially manufactured enclosures for their safe transportation and storage.

3.1.10 Special Warning labels

The SCUBA-2 Multichannel Electronics may have heat dissipating components, which may heat up above 50 degrees C. In order to protect designers and maintenance personnel from touching high temperature surface, the appropriate warning label has to be used to indicate hot surface areas.

All light emitting connectors have to be labelled to warn designers and maintenance personnel about the potential danger of eye damage.

Any equipment, which is operated during its development stage in the province of Québec has to have all warning labels in French as per the Québec Province Occupational Health and Safety Regulations.

3.2 ELECTRICAL

3.2.1 Electric shock

There will be several electrical power cables, of various voltages, required for the operation of the SCUBA-2 instrument and associated systems.

The use of only UL and CSA compliant connectors, wiring and practices shall be employed on the SCUBA- 2 instrument.

All electrical connections exceeding 110Vac shall be mechanically shielded to prevent accidental contact by staff. Where there is the possible danger of staff coming into contact with live terminals, mechanical interlock isolating arrangements shall be built into the equipment to eliminate these shields shall be identified with Canadian Standard compliant 'Danger – *** Voltage' warning labels.

All power isolating switches and breakers shall be clearly identified with CSA and UL compliant labels.

3.2.2 Access

The SCUBA-2 Instrument shall be designed to be serviced on the telescope and to this end the JAC staff engineers shall take responsibility for the design, manufacture and installation of suitable access platforms, ladders and walkways necessary to meet this objective.

Adequate maintenance and operational working space, as would be required by OSHA 1910.303, that affords safe access to all electronic and electrical enclosures, shall be provided when the instrument is mounted on the telescope.

3.2.3 Over-current protection

The SCUBA-2 instruments and the electronic sub-assemblies shall be protected by either fuses, circuit breakers or other current limiting devices to prevent other damage in the event of short-circuit or component failure events.

Primary fuses and circuit breakers should be rated to afford protection to the power cabling supplying the equipment during over-current events.

Secondary equipment fuses circuit breakers and other current limiting devices shall be rated to protect the equipment from damage during over-current events.

Fuses, circuit breakers and other current limiting devices shall be readily accessible and clearly identified with a circuit reference, rating and duty.

3.2.4 Over-heating prevention and protection

The SCUBA-2 Electronics units shall be fitted with over-temperature sensors and alarms. If necessary, forced cooling fans shall be included to maintain operational temperature within electronic enclosures. The JAC shall be responsible for ducting excessive heat away from electronic enclosure areas on the telescope.

3.2.5 Interlock protection

Interlocks have been identified for the instrument and will be detailed in the Service & Maintenance Manual.

Where fault finding on live electrical power supplies is envisaged, the means to defeat the mechanical interlock isolator arrangements shall be provided for use by competent persons. The JCMT Chief Engineer shall ensure that adequate control procedures are established to prevent abuse of this facility.

3.2.6 Mechanisms

The operation of all mechanisms and the associated limit switch and position movement control and monitoring hardware and software will be such that under no circumstances shall a failure causing a mechanism to hit a hard limit cause damage to that mechanism or other damage or create a personnel safety risk. Some failure modes will require manual intervention and access to the internals of the instrument may be necessary to do so. Under such circumstances, mechanical interlocking of mechanisms shall be incorporated to prevent movement of internal mechanisms.

Mechanisms will not move upon initialisation of the software, or upon power up, until specifically commanded to do so

3.2.7 Grounding

The SCUBA-2 design will adopt an Electrical Grounding Scheme, which will satisfy the following criteria.

- a. **Grounding and bonding of all equipment to eliminate electric shock risk.**
- b. **Avoidance of ground loop currents and noise causing unreliable operation.**
- c. **Protection of sensitive components due to static.**
- d. **All covers and sections of MCE, POL-2 and FTS-2 shall be fitted with ground straps and reliance of through assembly bolts to effect ground paths shall not be assumed.**
- e. **Motors must be ground bonded back to their circuit-breaker ground point.**

3.2.8 Component Ratings

Components will be specified to cover the relevant Environmental range, and be de-rated for altitude. An approximate rule of thumb will be that components will be at least 50% over-rated wrt sea level.

The project will endeavour to ensure all commercially bought equipment will comply with the required environmental specifications. However, commercial equipment is not normally guaranteed to operate below 0 degrees C.

3.2.9 Cable ratings

Specified cables will be UL / CSA approved and rated for 70 degrees C operating temperature. Insulation and screening will be chosen to suit the Environmental Requirements and the specific requirement (EMC screening, flexibility over the temperature range, abrasive considerations etc.).

3.2.10 Static Precautions

A set of guidelines will be developed to protect sensitive components (particularly the detector arrays) and electronic sub-units from static discharge damage, which is a considerable risk on high altitude sites.

3.3 HANDLING

3.3.1 General Handling

The design of the SCUBA-2 instruments addresses the following to satisfy safe handling requirements.

- **Provision of lifting points on the main instrument and sub-assemblies.**
- **Handles and lifting points for smaller assemblies**
- **Layout design to facilitate assembly/disassembly.**
- **Design of Shipping Containers to facilitate safe handling.**

3.3.2 Assembly/disassembly of the instrument

SCUBA-2 shall be designed to allow disassembly and removal of major components in a safe, convenient way. Nevertheless, some of the sub-assemblies are large and heavy, and will require adherence to procedures to avoid injury risk to personnel. The basic methods will be described in the CDR documents, and will be developed in detail in the SCUBA-2 O&M Manuals.

3.3.3 Optical component handling

Personnel safety issues are concerned with handling the heavy auxiliary instruments.

Safe optical component handling will be dealt with by means of careful optical assembly designs which provide stable, stress free mounting and safe disassembly. These procedures will be described in detail in the POL-2 and FTS-2 O&M Manuals.

3.4 GENERAL SERVICE RELATED

3.4.1 Lasers (for alignment Use)

The specification of the lasers for alignment work is TBD, but a minimum power laser consistent with adequate performance will be selected. The laser and its use will comply with US regulations. The design of the SCUBA-2 hardware will minimise the risk of accidental reflections and other potential sources of eye damage.

Appropriate warning and identification labels will be fitted.

Manuals will specify the procedures for use and use of appropriate Safety Goggles or Glasses, which will be provided as part of the Site Safety Equipment.

3.4.2 Identification and Warning Labels

For each relevant area, appropriate identification and warning labels will be identified on the detail drawings for fitting on during the SCUBA-2 instruments manufacturing stage.

Areas to be covered include:

Mechanical (Weights, CofG, Access Hatches, Motion Dangers, etc)

Laser

Electrical (cable/ connector identification, fuse/ circuit breaker ratings etc)

4. GENERALISED SCUBA-2 INSTRUMENTS RISK AND SAFETY ISSUES

4.1 GENERAL PROCEDURES

These general procedures are anticipated as being derived by the respective Canadian development institutions & JAC, and will cover the provision and use of supplied equipment and associated training of SCUBA-2 instruments' installation and commissioning staff.

General Procedures at the Base Facility.

General Procedures in the Dome

Lockout procedures

General Procedures in the Telescope Site Instrument Prep Room.

Most of these procedures will apply equally to when SCUBA-2 and its auxiliary instruments are in operation on the telescope, being serviced in the Instrument Preparation Room, or at the Base Facility.

4.2 CERTIFICATION OF HANDLING AND LIFTING EQUIPMENT

JAC are responsible for the certification of the handling truck for getting the instruments on/off the telescope.

4.3 INSTRUMENT RELATED ISSUES

4.3.1 Transportation between the Dome and the Instrument Prep Area

This will be necessary when the instruments are first delivered and thereafter when SCUBA-2 requires major servicing, modification or fault rectification.

The procedures will be described in the Service & Maintenance manual.

The issues of concern include:

Damage to the Instruments whilst moving them.

4.3.2 Mounting on/off the telescope

This refers to the transfer of instruments from/to a moving equipment to/from their operating position. This procedure will be described in the Service & Maintenance document.

The issues of concern include:

Transfer from the moving equipment to the mezzanine floor.

Prevention of damage to the instrument during mounting

Personnel safety whilst the moving equipment is in use.

Safety checks after mounting.

4.3.3 Electric shock

The design aims as described in Section 3.2 of this document should prevent any risk of shock in normal operation. Should an electrical fault occur which causes a danger to personnel (this may be due to causes external to SCUBA-2 instruments) all power supplies to SCUBA-2 shall be isolated by means of operating and an Emergency Stop Pushbutton that shall be designed and built into the instrument systems.

Otherwise, disconnection of electrical supplies and making the situation safe will be dealt with by the General Procedures referred to in 4.1 above.

Similarly, servicing of the instrument which requires removal of electrical components and the associated covers must be undertaken by authorised personnel according to General Procedures in 4.1 and instructions in the appropriate sections within the Maintenance Manual.

4.3.4 Assembly/disassembly of SCUBA-2 equipments

This will usually be done off the telescope. The procedures will be described in detail in their respective O&M Manuals.

4.4 SERVICE AND SUPPORT RELATED ISSUES

4.4.1 Compressed Air Safety

Not applicable to SCUBA-2 equipments

4.4.2 Coolants

Not applicable to SCUBA-2 equipments

4.4.3 Solvents

Cleaning procedures are TBD, and no specific solvents have yet been identified.

4.4.4 Tools

The O&M Manuals will describe in the relevant sections which tools, components etc are required for a particular task. Special tools supplied with SCUBA-2 will be clearly identified. Where a special handling cart is provided a place for special tools will be provided on the cart. Otherwise no special provision will be made. It is assumed that JAC will develop procedures and provide the necessary facilities for tool storage.

4.5 SERVICING

Generally, all the safety risks concerned with servicing are covered in the preceding sections. Many of the service checks will verify that the safety systems are still effective. The greatest dangers associated with servicing may well be associated with the overriding of mechanism movement with the instruments open. This sort of situation must be covered by, for example:

*Compliance with Facility procedures.
(Emergency, Lock out procedures)
Training
Detailed instructions (in the O&M Manuals)
Servicing carried out only by trained and authorised persons.*

Major servicing will be undertaken in the Instrument Prep Room. In the interests of the safety of SCUBA-2, appropriate bench areas, sub-assembly handling carts, and stands will be required and temporary and permanent storage areas available, to maintain a clear, safe, working environment.

5. SPECIFIC SAFETY AREAS OF SCUBA-2 TO BE CONSIDERED

These sections will in most cases be described in specific sections of the O&M Manuals.

The specific areas to be considered for each section are generally covered in Sections 3 and 4. At this stage, this section will remain as a list.

5.1 ARRIVAL ON SITE (SEA LEVEL)

- Equipment Required*
- Shipping Box weights and handling*
- Handling*
- Unpacking*
- Assembling*
- Setting Up*
- Training*
- Testing*
- Dis-assembling*
- Repacking*

5.2 TRANSPORT TO TELESCOPE

- Packing Box weights*
- Special requirements*

5.3 ARRIVAL AT OBSERVATORY

- Equipment required*
- Transfer to prep area*
- Handling*
- Unpacking*
- Assembling*
- Training*
- Testing*
- Disposal/ storage of packing*

5.4 INSTALLATION OF SCUBA-2 INSTRUMENTS ON THE TELESCOPE

- Equipment required*
- Handling*
- Transfer from prep area to dome floor*
- Mounting on telescope*
- Testing on telescope*

5.5 REMOVAL OF SCUBA-2 INSTRUMENTS FROM THE TELESCOPE

- Equipment required*
- Handling*
- Removal from Telescope*
- Transfer to Handling Truck*
- Transfer to Prep Room/ Storage.*

5.6 ROUTINE SERVICING/MAINTENANCE

- On the telescope*

In the prep room

5.7 EMERGENCY OR MAJOR REPAIR WORK

On the telescope

In the prep room

6. SAFETY RELATED DOCUMENTATION AND TRAINING.

6.1 DOCUMENTATION

This document will be updated as the design progresses. It may be supplemented by documents concerning similar concerns and safety requirements.

The respective SCUBA-2 instruments O&M Manuals will be the medium by which most of the methods and procedures for handling, servicing and use of SCUBA-2 are described.

6.2 TRAINING

To ensure that SCUBA-2 is used in a safe manner, with respect to both Personnel and Instrument Safety (damage), JAC staff will require suitable training. It is the responsibility of the project team to provide the appropriate level of training for JAC staff to perform these functions safely and proficiently.

The SCUBA-2 Canadian project manager shall make the necessary arrangements with the JAC Chief Engineer to satisfy this requirement.