# ICD-G0015

## "Gemini Facility Handling Equipment and Procedures for Instrumentation"

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AP/IPL assembling CP ISS

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# ICD-G0015
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# Contents

# 1. INTRODUCTION

This document is intended to describe the facility handling equipment and procedures for the Gemini 8m-Telescopes Instrumentation. This includes the science instruments, facility instruments and the Cassegrain assembly subsystems. The intent of this document is to aid in the development of the facility handling equipment and procedures, as a reference for instrument builders in developing appropriate interfaces and handling or service procedures and also as a reference for handling of the Cassegrain subsystems.

# 2. RELATED DOCUMENTS AND DRAWINGS.

## *2.1. Documents.*

1. PG-I-G0010, Gemini Instruments site safety policy.
2. Gemini ICD 1.9/2.7 "Science instruments to facility handling equipment".
3. Gemini ICD 1.5.3/1.9 "ISS to science instrument ICD"
4. MAN-I-G0006, Gemini 8-M Telescopes Facility Air Pallet Operation and Service Manual
5. MAN-I-G0007, Gemini 8-M Telescopes Facility Gantry Cranes Operation and Service Manual
6. MAN-I-G0008, Gemini 8-M Telescopes Facility Instrument Platform Lift Operation and Service Manual
7. MAN-I-G0009, Gemini 8-M Telescopes Instrument Support Structure and Ballast Weight Assemblies Operation and Service Manual
8. MAN-I-G00010, Gemini 8-M Telescopes Cassegrain rotator and cable wrap Operation and Service Manual
9. MAN-I-G0014, Gemini 8-M Telescopes Instrument scale Operation and Service Manual

## *2.2. Drawings*

1. Drawing 45483-1 "Aluminum pallet". This drawing is the manufacturers fabrication submittal layout for the AP.
2. Drawing 89-GP-1000-2012 "Interface bracket". This is the handling interface component for the Cassegrain rotator to either the AP or the BW frame.
3. Drawing 89-GP-1000-2400 "Cable wrap lifting fixture". This is layout of the handling frame for the Cassegrain cable wrap assembly.
4. Drawing 89-GP-1000-2470 "Cable wrap lifting fixture on ballast weight/pallet". This drawing shown the handling frame mounted on a BW frame and air pallet.
5. Drawing 89-GP-1000-2475 "Rotator handling beams". This is the handling interface for the rotator or Cassegrain cable wrap support and drive system assembly.
6. Drawing 89-GP-1000-2480 "Mounting cable wrap layout". This drawing shows the cable wrap being offered up the M1 cell using the handling frame mounted on the BW frame/AP/IPL pallet combination.
7. Drawing 89-GP-1000-4010 " ISS base/AP interface foot (Long)"
8. Drawing 89-GP-1000-4011 " ISS base/AP interface foot (Short)"
9. Drawing 89-GP-1000-4012 " ISS base/AP interface foot retaining pin"
10. Drawing 89-GP-1000-6001 "Cassegrain handling layout". This drawing shows the Instrument platform lift and air pallet in relation to the Cassegrain when deployed for a side looking instrument.
11. Drawing 89-GP-1000-6002 "Instrument handling within the MK observatory". This drawing show the routes and method for moving instruments between the instrument assembly lab and the platform lift.
12. Drawing 89-GP-1000-6003 "Instrument handling on the observing floor". This drawing shows the deployment of the platform lift on the observing floor and telescope.
13. Drawing 89-GP-1000-6100 "Air pallet layout". This drawing shows the conceptual layout for the AP.
14. Drawing 89-GP-1000-6200 "Fixed Gantry crane layout"
15. Drawing 89-GP-1000-6201 "Lifting plate"
16. Drawing 89-GP-1000-6250 "Mobile Gantry crane layout"
17. Drawing 89-GP-1000-6300 "Instrument platform lift". This drawing shows the conceptual layout for the IPL.

18. Drawing 89-GP-1000-6310 "Instrument platform lift". This drawing shows the fabrication submittal layout for the IPL.

### *2.3. Photographs*

Various photographs of the handling equipment are available in the photo gallery on the Gemini web site under "Photo Gallery" and "Instrumentation", at http://www.gemini.edu/gallery/instrument/handling/handling.html. Each of the service manuals contains references to a comprehensive library of digital photographs showing the equipment in use.

### *2.4. Video*

A video was taken of the air pallet and gantry crane under test with a science instrument simulated by a facility ballast weight assembly. A copy of this video was sent to each Gemini national office and one is archived at IGPO.

## 3. FACILITY INSTRUMENT HANDLING EQUIPMENT

The facility handling equipment is described below. This equipment is intended for use during routine instrument handling and assembly of the Cassegrain subsystems. Suggested procedures for using it are detailed in later sections of this document.

### *3.1. A- frame (gantry) cranes.*

There are two types of A-frame gantry crane available as described below. They use a common hoist arrangement, spreader bars and chains.

A- frame (gantry) crane.

#### *3.1.1. Observing floor fixed gantry crane.*

At the time of writing, this equipment has been delivered to Hilo and the CP summit but not installed on the observing floors. The dome cranes have performed their functions during the assembly of the Cassegrain systems at both sites.

The primary use for this equipment is to lift the instrument on and off the instrument platform lift and to re-orient the instrument from upward to side looking. It will be fixed to the observing floor, spanning the IPL, which can move underneath it. It has two electric chain hoist blocks. The first of these is mounted on a motorized trolley, and is fitted with a spreader bar. The spreader bar will interface to the instruments by means of two chains fitted with 'foundry style' crane hooks to facilitate lifting and tilting of the instrument about an axis that passes through the hook centers (The crane hooks may be replaced by more secure custom keyhole lifting plates). The second hoist will use a master link, chain and shackle assembly for attaching to an "A" bracket on the instrument. This hoist is used to lift the instrument and control the tilt. The hoist trolleys are connected to each other.

*3.1.2. Instrument assembly/disassembly area gantry cranes (Both summit labs and the Hilo base facility lab).*

The primary use for this equipment is to lift the instrument on and off the air pallet and to handle large instrument components within the labs. They are fitted with air bearings to facilitate movement. When the air bearings are activated, the unit is manually propelled. It has two electric chain hoist blocks. The first of these is mounted on a motorized trolley, and is fitted with a spreader bar. The spreader bar will interface to the instruments by means of two chains fitted with 'foundry style' crane hooks to facilitate lifting and tilting of the instrument about an axis that passes through the hook centers. (The crane hooks may be replaced by more secure custom keyhole lifting plates). The second hoist will use a master link, chain and shackle assembly for attaching to an "A" bracket or swivel eye on the instrument. This hoist is used to lift the instrument and control the tilt. The hoist trolleys are connected to each other so that they maintain separation and traverse together.

*3.1.3. Load capacity.*

The gantry and air bearings have a load capacity of 4,500Kg. The two hoists capacities are 2,700Kg and 1,800Kg.

*3.1.4. Critical dimensions for Fixed gantry crane*

Span: 6,000mm
Overall height: 5,000mm
2,700Kg Hoist max under-hook height: 3,460mm
1,800Kg Hoist max under-hook height: 2,650mm
Distance between hoist hooks: 2,020mm

*3.1.5. Critical dimensions of Instrument assembly area gantry crane*

Span: 4,877mm
Overall height: 2438mm to 4572mm increments of 304.8mm (Limited to 3,657mm in lab)
2,700Kg Hoist max under-hook height: 3,479 mm, 2,260mm (in summit lab)
1,800Kg Hoist max under-hook height: 3,669mm, 2,450mm (in summit lab)
Distance between hoist hooks: 2,020mm

*3.1.6. Spreader bar.*

The spreader bar has a load capacity of 2,600Kg.
The bail arm positions are adjustable in span from a maximum of 72 inches, down to 16 inches, in increments of 4 inches.
The spreader bar requires headroom of 15 inches.

*3.1.7. Chain slings.*

Two 5/16" chain slings are provided with foundry hooks at each end, 900mm long. Each sling is made up of components rated for a safe working load of 2000Kg, including the chains.

The foundry hooks are selected to work with pintels of 50mm diameter.

A chain, master link and shackle assembly is provided for the single point lift hoist, 900mm long. The sling is made up of components rated for a safe working load of 2000Kg, including the chains.

*3.1.8. Hoist controls.*

There are two pendant hoist controls, one for each hoist. Each control has an up/down two stage push-button control for slow/fast operation. A forward/reverse push-button control is provided on the 2,700Kg hoist control for the motorized trolley. This moves both hoists simultaneously.

*3.1.9. Techniques for lifting and transferring loads.*

It has been found that when transferring from the AP, it is better to take partial strain on the hoists when the AP air bearings are activated and brakes/guide wheel de-activated. This has the effect of centering the load and there is little or no swinging of the load when the full weight is taken.

When setting loads down on the AP, it is better to position the AP and take the weight by raising the scissors lift of the AP (if the load is allowable for the scissors lift, <6,000Lbf).

*3.1.10. Experience with handling dummy Cassegrain components.*

There were no major problems experienced with the gantry crane and hoists during use. Some minor difficulties were experienced which are currently being addressed. See the gantry crane operation manual for details of problems/fixes.

***3.2. Air bearing pallets (AP's).***

These devices are mobile hand propelled air bearing platforms on which the instruments can be maneuvered within the observatory or positioned during assembly. The air pallets combine a fine motion hydraulic lift with manual XY motion and rotation in Z required to align the instrument interfaces during mounting.

Air bearing pallets (AP's).

They consist of an extruded aluminum pallet that supports an air over hydraulic scissor lift platform. Four air bearing pads are used to provide manual mobility.

There will be three identical air bearing pallets at each observatory. At Gemini North, one will be allocated to the HBF lab, although transport of the AP's to and from the summit when required is straightforward.

*3.2.1. Load capacities.*

The air over hydraulic scissors lift has a load capacity of 2,700Kg

The air bearings have been tested with a load of 4,000Kg (with the scissor lift lowered fully).

### *3.2.2. Critical dimensions.*

Overall size approx 2.4m x 1.4m x 1.3m (LxBxH) including handle.
The maximum platform height, fully raised is 1346mm
The minimum platform height fully lowered is 279mm.
The air bearings lift the AP by as much as 19mm when activated.

### *3.2.3. Controls.*

A brake lever is provided on the extendible push handle. Actuation of the brake lever forces a brake pad onto the floor, releasing the lever releases the pressure and the pad retracts.

A control panel is located on the push handle that provides the following controls:

1. Pressure gauges and pressure regulators for the air supply, air bearings in the 'high' loaded condition, air bearings in the 'low' loaded condition, the scissor lift and brake.
2. A 'high/low' range rocker switch is provided for the air bearings.
3. An 'up/down' rocker switch is provided for the scissor lift.
4. A brake 'on/off' switch is provided, this can act as a parking brake while the unit is up on air.
5. A guide wheel 'on/off' rocker switch is provided. Activation of this switch will lower a central guide wheel and press it onto the floor.

### *3.2.4. Instrument interface.*

The mechanical interface to the instrument is a flat surface with four locating bosses 100mm diameter and 15mm high. The bosses have a central hole 70mm in diameter and are made from UHMWP (polythene). They are arranged in a square pattern 1200mm per side and the center of the pattern should lie on the design CofG of the instrument.

The lifting platform edge extends out 114mm on each side from the center of the left and right interface pads.

The platform edges extend out 508mm from the center of front interface pads and 406mm from the center of the rear interface pads.

### *3.2.5. Scissor lift.*

The lift rate is deliberately slow for fine control of height and is continuously adjustable by means of the supply pressure to the air motor. The scissor lift will only operate with the air bearings toggle switch on. To prevent flotation of the AP when lifting the table, the supply pressure to the air bearing can be reduced.

### *3.2.6. Air bearing replacement.*

The air bearings can be removed and replaced without moving the air pallet. Two retaining clips must be pushed out and the bearing retracted. The orientation of the replacement bearing is indicated on a sticker above the air bearing pad. The air inlet hole of the air bearing must be aligned with the supply hole in the AP base.

### *3.2.7. Experience with AP's handling dummy Cassegrain components*

There were no major problems experienced with the AP's during use. It does take a little time to get familiar with the controls, particularly on the MK summit. Maneuvering the AP is a two person operation. Some minor difficulties were experienced which are currently being addressed. See the air pallet operation manual for details of problems/fixes.

### 3.3. Cassegrain Instrument Platform Lift (IPL).

Cassegrain Instrument Platform Lift (IPL).

This device is a large, self-propelled hydraulic scissor lift. It provides a platform onto which the instrument and service personnel can be offered up to the side looking ports of the ISS. The instrument will be mounted on the Cassegrain air-bearing pallet during these operations. The handrails on the front of the IPL are post and socket type with snap chains. They can be re-configured for use with the science or facility instruments. An auxiliary lift is provided for access of equipment and personnel to the raised platform.

This lift will have an interface to the telescope interlock. This will prevent mobility of the lift when the telescope is not in the locked position and similarly prevent movement of the telescope when the lift is not locked in its storage position. At the time of writing the interlock has not been implemented.

The unit is designed to work with a guide rail fitted with end of travel limits. An IGUS chain/guide channel combination is designed to carry mechanical services to the lift. These features have not been implemented at either site at the time of writing.

#### 3.3.1. Load capacities.

Main deck: 4,500Kg.
Auxiliary lift: 230Kg.

#### 3.3.2. Critical dimensions

Main deck: 5,200mm x 5,000mm (L x B)
Maximum deck height fully raised: 2,560mm
Minimum deck height fully lowered: 889mm
Handrail height: 1067mm.

#### 3.3.3. Experience assembling the Cassegrain subsystems to the telescopes.

There were no major problems with the IPL during this procedure at either site. Some minor difficulties were experienced with the IPL and telescope/observing floor interface and these are being addressed. See the IPL operator's manual for details.

### 3.4. Reversible boom crane

This device is a hand propelled boom hoist. It has a cantilevered hand operated hydraulic boom with a single hook at the end. The boom can be incrementally extended out manually, when there is no load on it. It is intended for use in handling smaller instrument components in the labs but may also see service in installing the dummy calibration unit components on the ISS.

At the time of writing, one of these devices is available in the HBF lab, a second one will be procured for the summit.

#### 3.4.1. Load capacities.

Boom retracted: 450Kg.
Boom extended: 225Kg.

#### 3.4.2. Critical dimensions

Boom length fully retracted: 1,000mm
Boom length extended fully extended: 2,000mm
Under-hook height, boom level: 1,400mm
Size, excluding boom which sticks out beyond this: 1,720mm x 810mm x 1,550mm. (LxBxH)

### 3.5. Interface components for handling equipment.

The components described in this section are required interface components to the handling equipment. The handling frame for the Cassegrain Cable Wrap is also used as a support frame allowing pre-assembly off the telescope. These items are attached to the appropriate handling equipment or stored in the Instrument group Lista storage cabinet in the Instrument lab or in the Lista toolbox on the IPL.

#### 3.5.1. Rotator lifting eyes.

These are three M20 lifting eyes providing an interface to the cranes via shackles and lifting straps. These are standard bought in components and a set was supplied with each rotator. It is acceptable to use three lifting slings in a choker arrangement as an alternative if care is taken not to rub against the rotator encoder tape.

#### 3.5.2. Rotator/AP interface bracket

Drawing 89-GP-1000-2012. These four components provide an interface between the rotator and the air pallet or the ballast weight support frame. At the time of writing none of these components are available and the handling beams have been used instead.

#### 3.5.3. Rotator handling beams

Drawing 89-GP-1000-2475.

These are two ‘I’ beams that provide a matching bolt pattern to the feet of a ballast weight support frame. Once assembled to the frame, the cable wrap support and drive system can be placed on top (or rotator) prior to mounting on the M1 cell. Two ½ inch lifting eyes are provided on the top of each beam. These can be used to restrain the support and drive system during transport on the IPL.

Only one set (of two) have been made.

*3.5.4. Cable wrap handling frame.*

Drawing 89-GP-1000-2400.

This lifting frame is cross shaped and made from 'I' section and 'C' channel bolted together. When assembled, it provides a frame for the assembly of the Cassegrain cable wrap and its subsequent handling. Four ½ inch lifting eyes are provided as interface to a crane. It also provides four interface pads on the underside to the AP, floor or ballast weight frame. These pads have an M6 tapped hole used to retain the frame in conjunction with clamp plates.

The frame can be split down the middle, for transport of the assembled cable wrap halves. It can also be disassembled into its individual members for storage and transport between telescope sites.

Only one of these frames was made.

*3.5.5. ISS lifting fixture.*

Drawing 89-GP-1000-3009

These are two steel weldments that provide matching hole patterns to the ISS instrument ports. Pintels are provided as an interface to the foundry hooks/chain/spreader bar arrangement. Using these components mounted near the top of the ISS and a suitable attachment point near the bottom (Two 12mm eyebolts were used sharing load), the ISS can be lifted and if necessary tilted through 90 degrees.

Only two of these were made.

*3.5.6. ISS/Air pallet interface pads.*

Drawing 89-GP-1000-4008 and 4009

These pads can be attached to the ISS instrument interface pads (usually one at each corner of the base) and at four locations on the ISS body bottom (when the base is removed). The can act as 'feet' when the ISS, base or body is sitting on a flat surface. In addition, they provide a spigot that engages the annular pads of the air pallet providing a course locating feature and security against lateral movement during transport.

There are four additional pads that are identical but extended in length. These are intended to mount to the ISS base for use with the AP and provide access to the fasteners for the ISS base.

*3.5.7. ISS base/AP interface foot (Long)*

Drawing 89-GP-1000-4010

These feet are attached to four locating pins on the corners of the ISS base. They are used in the installation of the A&G unit.

*3.5.8. ISS base/AP interface foot (Short)*

Drawing 89-GP-1000-4011

These feet are attached to four locating pins on the corners of the ISS base. They are used in the installation of the A&G unit.

*3.5.9. ISS base/AP interface foot retaining pin*

Drawing 89-GP-1000-4012

These pins retain the interface feet on the locating pins.

*3.5.10. ISS base restraint chains.*
These are four 5/16 lifting chains with shackles at each end and a swivel in the middle, 42" long. They are used to suspend the ISS base/A&G assembly on the ISS body when the supporting AP is removed and replaced with the IPL/AP combination.

8 of these were made, 4 for each site.

*3.5.11. ISS base and body lifting eyes*
4xM14 and 4xM12 lifting eyes are required. Rating should be for 1000Kg each or greater.

These are standard bought in items.

*3.5.12. Lifting plate*
Drawing 89-GP-1000-6201
These components provide a secure 'keyhole' interface between the instrument lifting pintels and the spreader bar chains.

# 4. INSTRUMENT HANDLING PROCEDURES

The handling procedures using specific facility equipment are detailed thoroughly in the operations manuals for that equipment with detailed instructions, cautions, tool lists and checklists. They are summarized here to give an overview for instrument builders.

## *4.1. Servicing instruments in the instrument preparation area*

These activities will depend greatly on the instrument but in general, the instrument will be supported on its own handling rig or mounting feet, which will provide a stable base for the instrument in a fully or partially assembled state. The gantry crane can be used to lift and move heavy subassemblies from the instrument. The air pallet may also provide some mobility if desired. The reversible boom crane can be used to handle smaller instrument parts.

The instrument should provide 50mm diameter pintels towards the ISS interface and a lifting eye or 'A' bracket towards the rear for use with the gantry cranes. Subassemblies too heavy for manual lifting will require safe lifting points for use with the hoists or boom crane. Lifting eyes, lifting swivels or 'A' brackets are all acceptable for use with shackle/chain or shackle/fabric sling lifting accessories. A variety of these accessories will be available on site. The mechanical interfaces must be designed to compliment this method of handling.

For large instruments that cannot be easily re-oriented in the lab using the standard equipment (due to lack of headroom), the preferred orientation during servicing will be side looking or 'flat', the same orientation suggested for transport on the air pallet.

## *4.2. Moving instruments from lab onto the IPL on the observing floor*

*4.2.1. Transfer to Air Pallet.*
First the instrument must be transferred from its handling rig (or the floor) onto the air pallet. The gantry crane can accomplish this. This can also be done using only the air pallet if the instrument/handling rig is designed to straddle the lowered air pallet. Either way is acceptable. The orientation of the instrument on the handling pallet depends on its size and Center of Gravity

in the transported state (could be without electronics for example) and should take account of the available space in the corridors and doorways leading from the lab. The suggested orientation is that of the ‘side looking orientation when the telescope is at zenith. Instruments that approach the allowable space envelope in dimension will be transported with the long axis in the direction of travel. It is desirable to lift the instrument to the approximate height by means of the gantry crane, level it and then transfer the load by raising the AP scissors lift.

#### *4.2.2. Moving from assembly lab level (level 2) to observing floor level (level 5).*

From the prep room, the handling cart and supported instrument must negotiate a door and a sharp left bend into a corridor (212 MK) which leads to the vestibule (218 MK) connecting the support facility to the telescope enclosure. The junction at the vestibule requires negotiating another door and a slight change in course. At the end of the vestibule there is access to the service elevator or a staging platform through a door. The route taken from this location will depend on the size of the instrument. If possible, the service elevator will be used but for instruments too large to use the lift, the route will be via the staging platform. Using the jib crane hoists and spreader bar provided, the instrument will be lifted over the safety rail and down to the lower telescope floor onto a second air pallet. From there, the instrument is transported across the basement floor (level 1) to the large platform lift and on up to the observing floor.

There are gaps and discontinuities in the floor along this route (two expansion joints and a gap at the elevator). At the time of writing, sheet metal and tape must be used to allow operation of the air pallet over these features.

#### *4.2.3. Transfer to the IPL*

The telescope will be oriented on the service position and locked. The instrument platform lift will then be deployed onto the telescope. The instrument will then be moved into position under the fixed gantry crane and hoisted up. The instrument platform lift with air pallet on board will then be moved under the suspended instrument and the instrument lowered onto it. During this process the instrument may be re-oriented in the position for mounting on the ISS. The instrument platform lift will then be moved back onto the telescope into the service position and raised to offer the instrument to the ISS. The instrument is then transferred onto the ISS and bolted to the telescope (using the alignment scheme specific to that instrument ).

It is possible to use the dome crane(s) for the lifting operation without using the fixed gantry crane and will be necessary in any case if the instrument used the service elevator to access the observing floor.

#### *4.2.4. Air bearings and coping with gaps and irregularities in the floor*

At the time of writing there were many areas where gaps and discontinuities in the observatory floor, telescope and IPL deck would stop the air bearings. These can be bridged by means of thin galvanized sheet steel ~ 1mm and aluminum tape. It is planned to provide a more permanent and convenient solution, but this is a viable if tedious work-around.

Where the floor is simply irregular, as in some areas of the basement floor, it sometimes only necessary to increase the air pressure to the air bearings (40-50p.s.i.) until the bad area is cleared.

### *4.3. Orienting instruments for upward or side looking operation*

The normal orientation for instruments on the air pallet during transport will be the same as for side looking mounting when the telescope is at zenith. In this case, the instrument must be re-oriented for mounting on the upward looking port. This will be accomplished on the observing floor with the fixed gantry crane. The air pallet must be positioned underneath the gantry crane with the instrument mounting interface plane perpendicular to the gantry I-beam direction. The foundry crane hooks and the shackle will be engaged and the instrument raised off the air pallet. The chain block controlling the foundry hooks will be used to pull the front of the instrument up and the one controlling the shackle lowered until the entire instrument is supported off the chain block with the spreader bar. The single chain can now be removed and the instrument lowered onto the air pallet, adjusting the air pallet position as required.

This process will be reversed when the instrument is removed for changing to a side looking port or prior to transport through the observatory.

The dome cranes can also be used to perform these operations.

### *4.4. Mounting instruments on the ISS*

Mounting instruments on the ISS has many issues in common with the mounting the ballast weight assemblies that are in effect dummy instruments. The mounting detail and procedures developed for this are detailed in the ballast weight service manuals referenced in the documents section of this ICD.

#### *4.4.1. Design considerations for the instrument builder.*

It is not acceptable to put large side forces on the M12 tapped fastener holes on the ISS or the 30mm diameter position defining hole during the mounting process. This could cause damage or rapid wear to the ISS that would be very difficult and costly to repair and is potentially dangerous. The instrument interface and mounting procedure must be designed to avoid this, as is done for the facility ballast weights. There are two key elements in the suggested scheme detailed below:

a) A hardened interface component is first attached to the ISS and its fasteners fully tightened. This is small, accurately made and can be mounted by hand. It is in some sense sacrificial in case of damage and wear.
b) The weight of the instrument is transferred over to the ISS and the position defined in XY (by the interface components) before the instrument fasteners are engaged.

It should be noted that for loads not centered on the interface pads of the air pallet, there may be a significant tilt that can prevent proper mating of the interfaces.

#### *4.4.2. Suggested procedure (used with facility ballast weight assemblies)*

This process will start with the instrument sitting on the Air Pallet in the proper orientation for mounting on the ISS. The Air Pallet shall either be mounted on the instrument platform lift or directly on the observing floor (most upward looking instruments). It is assumed that the telescope is locked in the service position pointing at Zenith, that the instrument or ballast weight assembly has been removed from the port and that the appropriate instrument interface fixtures (if used) are already attached to the ISS in preparation for the mounting. The procedure is slightly different for upward or side looking mounting.

a) Side looking mounting. The Cassegrain rotator will be moved to present the mounting face towards the platform lift (this may require overriding the rotator/telescope interlock) .The instrument platform lift will be moved into a predetermined position, aligned by marks painted on the observing floor or possibly with end stop switches. The instrument platform lift will be raised to the transfer position. The instrument, on the air pallet will be lifted to its mount position and maneuvered to present its mechanical interface to the ISS, adjusting height as required (the accuracy of this alignment is assumed to be within 5mm). The instrument can then be offered to the ISS interface, engaging the alignment fixtures or features meant to support the instrument weight and the air pallet platform lowered, transferring the weight of the instrument to the ISS. If a semi-kinematic 'V' and 'flat' are used this process will align the instrument in the XY plane (Gemini Systems instrument coordinate systems). In the case of the ballast weights, a pinch set screw is used to pull against the frame against the defining pin. The instrument can then be bolted to the ISS interface, and the services attached.
b) Upward looking mounting. This is very similar to the procedure described above but in the case of the kinematic mount, the instrument must be actively pushed or pulled into X and Y alignment defining features prior to bolting the instrument to the ISS port. Most instruments will use the air pallet sitting directly on the observing floor.

#### *4.4.3. Facility instrument, AO, Calibration unit.*
The facility instruments occupy dedicated port positions and are not required to change configuration frequently as is the case with the science instruments. They are not required to work on the upward looking port face. The same handling equipment used for the science instruments will be used for mounting and servicing but some configuration changes are required to the railings on the platform lift to avoid interference with the instrument volumes (if the instruments are present). The handrails and mounts on the platform lift are designed to accommodate this.

#### *4.4.4. Experience with mounting the facility ballast weights.*
This type of arrangement is used on the facility ballast weights detailed on drawings 89-GP-1000-4002 and 89-GP-1000-4007. At the time of writing this procedure has been done with the ballast weights, and positioning to 1mm or so is possible by eye and manual manipulation of the air pallet and scissor lift. Compliance of the activated air bearing helps the process.

It was noted that for loads not centered on the interface pads of the air pallet, there is a significant tilt of the ballast weight that can prevent proper mating of the interfaces.

#### *4.4.5. M12 tightening torque*
The M12 fasteners on the ISS were all tightened using a torque wrench set at 50 ftlbf. (68 Nm).

### *4.5. Servicing instruments on the ISS*

The types of servicing that are envisaged for instruments vary from simple inspection to change-out of heavy sub-assemblies for re-configuring the instrument (i.e. changing slit mask modules for GMOS). In addition, heavy or bulky diagnostic equipment may have to be operated near the instrument.

The procedure is slightly different between the upward and side looking instrument described as follows.

a) Side mounted instrument. The instrument platform lift will be moved into place on the telescope and the forward handrails configured as appropriate. An operator on the lift will raise it to the correct height. Personnel and service items will then be moved onto the instrument platform lift by means of the auxiliary platform lift (if not already on it). The auxiliary platform lift will be used to lift personnel and equipment up to the raised platform.
b) Upward looking instruments. In this case the position of the method will depend on the location of the serviced items and on the instrument size. For the largest instruments the platform lift is too large to move underneath but can be used to give access to one side at a time (presumably the side where the services are connected). Gantry type stepladders can give simultaneous access to the other side if required.

The auxiliary platform lift is accessed by means of a ramp when in the lowered position. Handrails limit the width of equipment to approximately 700mm. Large items can be hoisted onto the IPL using the dome crane or fixed gantry crane.

### *4.6. Dismounting instruments.*

Disassembly is the reverse of the assembly procedure. The instrument scale can be useful in this process. The AP scissor lift can be raised until it is taking the full weight of the assembly as indicated by the scale before the fasteners are removed.

It is helpful if the AP interface pads contact the instrument interface pads evenly.

### *4.7. Acquisition and Guidance Unit.*

The A&G unit fits inside the ISS and is attached to the ISS base which must be removed for access.

#### *4.7.1. Moving to observing floor level*

At the time of writing the A&G unit cannot be fully assembled in the lab with the handling equipment and lifting interfaces provided due to lack of headroom. If it were fully assembled, it can use the same equipment and route as the science instruments.

Currently, the modules are moved individually using a pallet stacker via the service elevator.

#### *4.7.2. Craneage of part or fully assembled A&G mounted on ISS base*

Four M14 lifting eyes can be attached to the ISS base. The spreader bar/chains (lifting slings)/shackle arrangement can then be used as an interface to any hoist.

*4.7.3. Assembly to the ISS base.*

The current technique in use at MK is to assemble the A&G on the AP/IPL combination one module at a time on the observing floor. It is then transferred to an AP on the telescope mount base using the dome crane. The ISS base/A&G unit assembly will sit on the air pallet interfaced by the four extended ISS/Air pallet interface pads bolted to the ISS base corner instrument mounting pads.

*4.7.4. Engaging A&G assembly with ISS body.*

The A&G unit, on the ISS base with its extended interface feet will be supported on the AP which is in turn sitting on the telescope mount base. The air pallet will then be positioned under the ISS body and raised until the top of the A&G unit is in close proximity to the bottom of the ISS body. The rotational orientation of the ISS base should be checked with respect to the ISS body. This can be done by checking the position of the radial defining dowels on the ISS base against the mating grooves on the ISS body (one is offset to prevent misassembling). The A&G unit will then be maneuvered to align with the hole in the ISS body using the air pallet and the pallet raised fully, engaging the top of the A&G with the hole in the ISS body. Four M14 lifting eyes will be assembled to the tapped holes on the ISS base and a corresponding four M12 lifting eyes to the ISS body. The lifting eyes in the body will be offset slightly and should be placed symmetrically on each side with respect to the rotator axis. A set or four restraint chains with shackle ends are attached between each lifting eye pairs and the air pallet is then lowered, suspending the assembly off the ISS body.

*4.7.5. Mating ISS base with the ISS body.*

The extended feet can now be swapped for the short variety. The IPL, with an AP on board will be moved under the A&G/ISS base assembly. The IPL is then raised to take the weight off the chains. The chains can now be removed and the IPL/AP raised further to engage the ISS base radial defining pins with the mating features on the ISS body. The ISS base can now be raised further until the mating flanges are in contact. The instrument scale is used to measure the load on the air pallet during this operation with the selector set to 5 (sum of four load cells). The maximum load exerted should be 5,000lbf. The scale can be pre-set to Lbf or Kg and so a known mass should be used to verify the scale units. The ISS base bolts should now be engaged and the air pallet scissors lift lowered to just clear, transferring the weight of the A&G unit and base onto the ISS. The bolts can now be tightened evenly in three even stages to the final torque (20, 40, then 50 ftlbf) by means of a torque wrench, 4" drive extension and suitable socket.

If the instrument scale is not available, the process for mounting the ISS base to the ISS body is slightly different to avoid over-stressing the air pallet scissor lift and IPL. ISS base should be raised until a small (1-3mm) gap exists between the mating flanges *at its narrowest*. This gap should be checked all the way around as the ISS base is raised. The ISS base and body will not generally be perfectly parallel and one edge will close first. The fasteners should now be engaged and tightened keeping the gap parallel, lifting the base off the air pallet.

*4.7.6. Mounting the A&G unit electronics and GCAL/Dummy GCAL*

The A&G unit electronics thermal enclosures are mounted on a frame and this assembly shares the same ISS port as the GCAL unit. These items may all be mounted independently, one at a time on the ISS, although the GCAL unit will have to be mounted first and de-mounted last in order.

At the time of writing the exact procedure has not been released, but it the facility handling equipment has proven adequate to do this.

## 5. CASSEGRAIN ASSEMBLY SUBSYSTEMS

The subsystems of the Cassegrain assembly include the ISS, Cassegrain rotator and the Cassegrain cable wrap. These subassemblies will not be removed from the telescope in routine service but they may have to be for non-scheduled repair and have at least to be assembled during telescope commissioning.

The procedures for mounting/demounting these sub assemblies from the telescope and the ballast weight assemblies can be found in the relevant manuals referenced in the document section of this ICD.