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Angell Hall Observatory

December 2006

Some Basic Rules

1. There must be at least one qualified operator present at all times while the telescope is in use.
2. Two people should be present at all times for safety reasons.
3. In the event of a personal emergency, **dial 911 immediately** and worry about the telescope latter. Please use the emergency contacts listed on the phone list in the control room to let others know about the emergency.
4. No smoking anywhere within a university building, including the roof
5. No food or drink in the dome. Please use caution in the control room.
6. Access for the public or for classes is through the roof door. Do not bring groups into the control room or up the spiral stair.
7. Keep the control room door closed to prevent anyone from wandering in while you're in the dome.
8. Do not leave the dome open or the telescope running and unattended.
9. Check the white board for telescope status before starting up the 'scope.
10. Always check the date and time before running the tcs program.
11. Make sure the telescope is stowed properly before leaving. Check the troubleshooting section and use the website, astro-labs email or phone list to report any problems.
12. Classes have priority and run 7 – 11 PM Monday – Thursday. The student astronomical society has priority on Friday evenings for open houses. Otherwise, the observatory is first-come first-served. Please check with the department before scheduling a group.
13. NEVER point the telescope at the Sun since serious damage WILL result. If using the 'scope during daylight hours, keep the shadow of the dome on the 'scope to prevent accidentally allowing too much light into the optics.

Some Basic Rules 1
Starting Up 4
Control Room 4
Dome Opening 4
Aligning the Telescope 6
Shutting Down 7
Stowing the telescope 7
Closing the Dome 7
Control Room 8
Using TheSky 9
Linking 9
Appearance 9
Controlling the Telescope With TheSky 9
Handpaddle Operations 10
Focus 10
Moving the Telescope 10
Dome Rotation 11
The Telescope control System 12
The System 12
Setting the Date and Time 12
Setting the rates 12
Controlling the Telescope Without TheSky 13
Troubleshooting 16
Issues With the Dome 16
Telescope Pointing Problems 19
Problems With Telescope Motions 23
Other Problems 27
Appendix 1: Taking Images With the CCD Camera 28
Turning the Camera On and Setting up 28
Shutting Down 28
Capturing the Image 29
Appendix 2: Binoculars 30

Appendix 3: C8 use and care ____ *31*
Setting up ____ **31**
Shutting Down ____ **32**
Night Observing ____ **32**
Solar Observing ____ **34**
Appendix 4: History ____ *36*
Appendix 5: Telescope Description ____ *36*
Appendix 6: Comparison with other Michigan Telescopes ____ *36*
Appendix 7: Technical Information for the 0.4-m ____ *38*
Location ____ **38**
Optical Characteristics ____ **38**
Pointing Limits ____ **38**
Eyepieces ____ **39**
Appendix 8: Filters ____ *39*
Appendix 9: Technical Information for the C8s ____ *40*
Appendix 10: The Messier Objects and their coordinates ____ *40*
Appendix 11: Operator's Exam ____ *42*
Reporting Trouble ____ *43*

Starting Up

Control Room

1. Check the white board for any notes on telescope status.
2. Log in to the windows PC.
3. You'll need to know the current universal time to the nearest second. The naval observatory's universal time server is bookmarked in Firefox, although you'll have to frequently reload this page. Please note the computer's clock does not update regularly so it is not accurate enough.
4. Turn on the power strip on top of the blue electronics box. The telescope control system (tcs) computer next to the box will boot.
5. Once you have a prompt type *TIME* to check the time. This computer is set to UT, which is EST+5 hours or EDT + 4 hours. If the time is inaccurate, enter a time 5 – 10 seconds ahead of the current time, then press enter when the UT clock actually reaches that time.
6. Check the date by typing *DATE*. Note that the date changes at 0h UT! If it is inaccurate, type the correct date and press enter.
7. Type *tcs* to start the telescope control system.
8. On front of blue box, throw the following switches:
    a. MTR DRIVER CHASSIS up.
    b. Red HALT MOTORS out (press in to unlatch this).
    c. DRIVES up.
    d. TRACK up
    e. TRACK/AUX TRACK to TRACK (up – it should already be in this position)

    All other switches should be down (there are white dots on the top row of switches to indicate the operating position)
9. On the windows PC, open TheSky.
10. In the "Telescope" menu, click on "Link > Establish". A white cross hair cursor should appear at the center of the screen to indicate where the telescope is pointing. If not, see the trouble shooting section.
11. Head upstairs.

Dome Opening

1. Check the weather and the roof for obstructions, including possible snow and ice on the dome in cold months. Do not open the dome if there is anything that could possibly fall on the telescope, or if it is very humid.
2. Turn on the power strip on the desk to turn on the desk lamps.
3. Open the vents and turn on the ventilation fan (the control is located on the south wall, behind the "Hot 240" sign). Note you can do this early in the day to get the 'scope cooled off for better seeing.
4. Make sure the cover is still on the telescope and finder scope.
5. Remove the cord from the shelf with the dome shutter controls and plug it into the outlet below the shelf.
6. Push the **upper shutter** switch to open the upper shutter. It will stop automatically when fully open.
7. Push the **drop out shutter** switch left to turn on the hydraulics.
8. Once the upper shutter is about 1 m open, pull down on the handle on the far left side of the shelf to open the drop out shutter. Once it is all the way open the hydraulics will squeal. Release the handle and turn off the switch.
9. Once the upper shutter has stopped, turn off the switch and unplug the shutter controls. Be sure the cord is securely placed on the shelf so it cannot fall down while the dome is rotating.
10. Grab the cord sitting on the vent under the dome and plug it in.

Aligning the Telescope

1. Turn on the power strip on the desk if it isn't already on. This should turn on the tcs monitor and the red desk lamp.
2. Remove the finder cap and telescope cover. You will need to use the handpaddle and slew the telescope in order to reach the cover from the step ladder (See "Handpaddle Operations"). Unless you are tall, do not try to get the cover without using the stepladder! Do not slew due north since there is no software limit under the pole
3. On the tcs, select item 2 "movement menu"
4. Check the sidereal time "S. T. *hh mm ss*" on the tcs display.
5. Select item 3 "Select Library Object"
6. Enter a number between 401 and 424 equal to 401 + hours of sidereal time. E.g. if the sidereal time is 21h 57m, round the ST to 22h so 401 +ST = 423.
7. Answer "No" to "Any Changes". The coordinates will appear as the "Next Object" and "Slew enabled" will blink at the bottom of the screen.
8. Select item 7 "Start slew" to slew the telescope to the object.
9. Center the star first in the finder scope then in the main telescope using the handpaddle (see the section "Handpaddle operations".) If no star is visible, see the troubleshooting section.
10. Hit <ESC> on the tcs to go back to the main menu.
11. select item 1 "Initialization Menu"
12. Select item 2 "Set telescope position"
13. Enter "0" for all values. Answer "No" to "Any Changes"
14. Hit <ESC> on the tcs to go back to the main menu, then select 2 for "Movement Menu".
15. The telescope is now ready for observing. You may need to repeat this process if the telescope tracking gets off for any reason.
16. Turn off the ventilation fan (it vibrates the 'scope.)

Shutting Down

Stowing the telescope

1. Put the cover on the telescope and finderscope. You may need to use the handpaddle to slew the telescope to a position where you can reach the front end of the telescope from the step stool. Unless you are tall, do not try to put the cover on without the stool.
2. In TheSky, go to the "telescope" menu and select "Link > Terminate".
3. Exit TheSky without saving. You can shut down the PC now.
4. On the tcs, select menu item 5 "set zenith position". It will tell you this sets all track rates to zero and ask "Any changes?". Tell it "NO", then select 7 "start slew" to move it to the zenith position.
5. Check the levels to make sure the telescope is really level. If necessary, use the handpaddle to make fine adjustments (this shouldn't happen if the telescope was tracking properly.)
6. Close the dome (see below).
7. Turn off the power strip, close all vents and turn off the dome lights and head downstairs.

Closing the Dome

1. All optics must be covered before proceeding.
2. Rotate the dome to its home position (check the white board)
3. Unplug the cord and place it on top of the vent.
4. Take the cord down from the shelf and plug it in.
5. Move the **upper shutter** switch to the right to start the upper shutter closing.
6. Move the **drop out shutter** switch left and push the lever up to raise the drop out shutter. Release the lever when the hydraulics squeal, indicating it is closed. Note the drop out shutter will not close if the upper shutter is too low. If it doesn't squeal, it isn't closed. If you cannot get the drop out shutter to close, try opening the upper shutter.
7. Turn off the **drop out shutter** switch.
8. The upper shutter will stop when it is closed. Turn off the **upper shutter** switch.
9. Unplug the shutter control cord and place it securely on the shelf. Do not leave the dome plugged in when not in use.

Control Room

1. On the front of the blue electronics box throw the following switches:
    a. TRACK off (down)
    b. DRIVES off (down)
    c. Red HALT MOTORS in all the way.
    d. MOTOR DRIVER CHASSIS off (down.) – the halt motors and horizon limits lights will go off.
2. Turn off the power strip (there is no graceful way to exit the tcs program, so you do not need to do anything to the tcs computer before this.)
3. Exit TheSky and LOG OFF the PC if you did not do so upstairs.
4. Make sure all the lights are off (check the spiral stair light!)

Using TheSky

Linking

1. When you set up the telescope, establish a link by going to the Telescope menu and selecting "Link > Establish
2. To disconnect, choose "Link > Terminate"
3. To suspend the link choose "Link > Suspend". Note this hides the crosshairs, but otherwise you are still linked to the telescope.
4. Do NOT change any of the telescope settings.

Appearance

1. The white cross hair indicates the current position of the telescope
2. The red target indicates the current selection
3. The mouse appears as an arrow pointer
4. The area visible to the telescope is displayed on the screen. If you zoom in or out, this area will no longer reflect what is visible to the telescope.

Controlling the Telescope With TheSky

1. Click an object to select it. The red target should appear around it and an information window should pop up.
2. If there is more than one object in the area (which there usually is) the top of the window will say "Object (1 of #):". There will be a name in the box on the same line, and an arrow indicating a drop down menu.
    a. Click the arrow to see the list of objects in the area where you clicked
    b. Select the object you want
3. Check the magnitude to make sure the object you selected will be visible. The limiting magnitude varies from night to night so you may have to do some experimenting. Generally, magnitude 10 and dimmer are completely invisible.
4. To send the coordinates to the tcs, click the green Newtonian-style telescope icon at the bottom of the information window ("slew").
5. After a few seconds, the window on the PC will close, "Slew Enabled" will blink on the bottom of the tcs screen and the coordinates will appear next to "NEXT OBJECT".
6. On the tcs, select item 7 "Start slew", check to make sure the telescope is clear, then hit enter. DO NOT MOVE THE TELESCOPE IF SOMEONE IS LOOKING THROUGH THE EYEPIECE! It's all fun and games until someone looses an eye…
7. Rotate the dome so the telescope is looking out the opening.
8. If using a narrow field of view eyepiece, it may be necessary to center the object with the handpaddle

Handpaddle Operations

There are two handpaddles, one in the dome and one in the control room. They are used for "manual" control of the telescope position, focus, and dome rotation. This is the best was to focus and to move the dome.

Focus

1. The focus buttons are at the top of the handpaddle.
    a. IN moves the secondary up away from the primary against gravity (moves the focal plane IN closer to the telescope body). This direction is preferred since gravity allows less play in the system.
    b. OUT moves the secondary down closer to the primary (moves the focal plane OUT away from the telescope body)
2. The "focus" reading from the encoder on the secondary is displayed on the tcs screen. The limits are between 481 and 3752. 1 mm of secondary movement is approximately 161 units on the encoder.
3. When switching directions there is a slight hystersis which will cause a 1 - 2 second delay before the mirror starts to move.
4. High speed focus motion is obtained by holding the SET button then pressing IN or OUT. If you release the SET button the focuser will slow. To resume high speed focus you must also release the focus button.
5. See the appendix for the eyepiece list with focus positions.
6. When you switch to a shorter focal length eyepiece (higher power), move the focus in.

Moving the Telescope

1. There are four direction buttons around the set button:
    a. N move north to higher dec
    b. E moves east, increasing RA
    c. S south to lower dec
    d. W west, decreaseing RA
2. There are 3 speeds:
    a. SLEW is the fastest for slewing or making major adjustments while looking in the finder
    b. SET is a slower speed for minor adjustments in the telescope position
    c. The telescope also moves at the "guide" speed, which normally tracks the motion of the sky.
3. To move the telescope, hold both the speed button and the direction button. E.g to move quickly east, hold down both SLEW and E. If only the direction button is pressed the 'scope moves at the guide speed

Dome Rotation

Note, although the tcs does have the capability to rotate the dome and track with the telescope, it moves the dome too often and without warning, and may crash the tcs if the dome gets stuck. Handpaddle control is the ONLY recommended way of moving the dome.

1. The dome rotation buttons are on the bottom of the handpaddle.
    a. R turns the dome right (clockwise)
    b. L turns the dome left (counter-clockwise)
2. The direction the dome is facing is listed as "DOME AZIMUTH" on the tcs screen. If you align the dome and telescope, you can control the dome from the control room from the control room. See the Telescope Control System – Aligning the dome" for instructions.

The Telescope control System

The System

This telescope is completely under computer control: one never moves it or the dome by hand except in an emergency. The computer hardware and software combination that control the telescope and dome are called the Telescope Control System (TCS).

Commands are sent to the TCS by means of the left hand keyboard in the dome or in the control room. It is possible (like most research telescopes today) to do all of the observing from the control room and never be in the dome.

1. The software is a menu driven system, whereby one enters numbers to select an option.
2. The current state of the telescope (where it is pointing, if it is tracking, time, etc) is displayed on the left hand (monochrome) computer monitor.
3. Most commands need to be followed by Enter to be accepted.
4. In almost all cases, hitting the ESC key cancels the current command.
5. If no command is executing, ESC should send you up one level in the menu tree.
6. If the TCS is blinking SLEW ENABLED but not actually moving, enter 8 followed by Enter to revert to an idle mode

Setting the Date and Time

The date and time should be set at the DOS prompt when you start the tcs computer. Any changes you make inside the tcs software will NOT affect the computer clock. However, if you need to change the time, follow the steps below.
Differences of only a couple seconds will have little effect, but differences of less than a minute can cause problems with pointing and for the telescope limits. The tcs runs on UT, which is EST + 5h. The date changes at 0h UT. You can check the time at http://tycho.usno.navy.mil/what.html.

1. Select item 1 “Set date and time” from the initialization menu.
2. Enter the UT date and time in the blanks provided. Include a few seconds lead time to execute the command.
3. Answer “No” to “Any changes” when the real UT equals the time you entered.
4. Report your changes using the webform or email (see “Reporting Trouble”)

Focusing

Miscellaneous menu item 4 allows you to move the focus. The limits will be listed at the bottom of the screen when you choose this item. See appendix 7 for approximate positions for focusing with the different eyepieces. See the section on focusing under Handpaddle Operations for more on the focuser.

Stopping the telescope

Movement menu item 8 “Stop” will stop the telescope in mid-slew. It will override the handpaddle, but only as long as the buttons are pressed. This will also clear an unwanted “SLEW ENABLED” message. It does not stop the telescope from tracking.
To stop the telescope tracking, either set the track rate to 0 (see above section), or use movement menu item 5, “set zenith position” (see the section on stowing the telescope).

Setting the rates

This should only be done if you are sure the track rates are not correct, or if you need greater precision (as for imaging). The rates will revert back to the programmed rates when the computer is rebooted. If the telescope isn’t tracking properly, please go through the troubleshooting guide before changing the rates.

1. Select item 3 “Rates menu” from the main menu page
2. Select item 1 “Set track rates”
3. Set the RA rate to 15.00 if it isn’t set to that already. Otherwise, try 15.04. All other rates should be zero.
4. Answer “No” to “Any changes”
5. Go back to the movement menu, point the telescope at a star, and make sure the telescope is tracking correctly. You may need to adjust the RA rate again to get the tracking rate right.
6. Report any changes via the web form or an email (see “Reporting Trouble”.)

Aligning the Dome

To align the dome and telescope:

1. Make sure the “Dome” switch is down (NOT on Autodome – it should stay in this position)
2. Point the telescope at a known object.
3. Center the dome opening on where the telescope is pointing
4. Go to the initialization menu.
5. Select item 3 “Set Dome Position”
6. Read the “TELESCOPE AZIMUTH” from the telescope position section of the tcs screen. Enter this value.
7. Answer “No” to “any changes?”
8. The “TELESCOPE AZIMUTH” and “DOME AZIMUTH” should now match. As the telescope tracks or when you move to another object you can control the dome from the control room by using the handpaddle and adjusting the dome azimuth to match the telescope azimuth

Controlling the Telescope Without TheSky

"Starhopping"

There are several ways to control the telescope without using TheSky. The most straightforward (though not the easiest) is to use the handpaddle. This will allow you to "starhop" – center the 'scope on a bright object then move in RA and dec to the location of a dim object. This is similar to the method used to find dim objects with the C-8s.

1. Choose a target object.
2. Find a bright object nearby. Determine the difference in RA and dec to your target in arcminutes.
3. Using the handpaddle, center the bright object in the finder, then in the 35 mm eyepiece.
4. Use movement menu item 2 "Set offset" to enter the RA and dec in arc seconds (999.9 maximum) to get to the target.
5. Use movement menu item 7 "Start slew" to slew to the new object.
6. Rotate the dome so the 'scope is pointed out the opening
7. If necessary, use the handpaddle to center the object.

Manual entry of coordinates:

Movement menu item 1 "Set Slew Position" lets you enter the coordinates by hand. You need to know the RA and dec of the object, and the epoch for the RA and dec. Lists are frequently published for epoch 2000, while software usually gives the coordinates for the current year. The Messier catalog is in the appendix.

1. Select item 1 from the movement menu.
2. Enter the RA in the format hh mm ss.s
3. Enter the dec in the format dd mm ss.s
4. Enter the epoch in the format yyyy.y (it says 19xx.x, but it will take 20xx.x)
5. Answer 'No" to "Any changes?"
6. The coordinates you entered should appear on the "Next Object" line and 'SLEW ENABLED" should blink at the bottom of the screen. If "Target out of Range" appears on the screen, the object is outside the pointing limits of the telescope. The limits are roughly +47 to –32 dec and the sidereal time ±5 hours RA. Go back to step 1 and enter a different set of coordinates.
7. To cancel your selection press <esc> any time before hitting <Enter>, or use menu item 8 to cancel the coordinates or stop the slew.
8. Select item 7 "Start Slew" and press <Enter> to slew to the object.

Using library objects:

Movement menu item 3 "Select Library Object" lets you select an object from the tcs library. This is normally used to align the telescope.

1. Determine which library object you want to use:
    a. The library is the Sommers-Bausch Observatory Catalog of Astronomical Objects. More information on this catalog (including the object lists) are available from the Sommers-Bausch Observatory at http://lyra.colorado.edu/sbo/manuals/sbocatalog/sbocatalog.html. There are 225 objects in the library, listed by their SBO number:

Catalog	Library number	Numbering system
Messier	001 – 109	Messier catalog number
Mullaney & McCall	201 – 305	M&M number + 200
Ephemeris Star List	401 – 424	RA to nearest hour + 400, dec between 40 & 50º
Bright Star List	501 – 513	Brightest star order + 500
Special Objects	514 - 528	513 + next SBO object

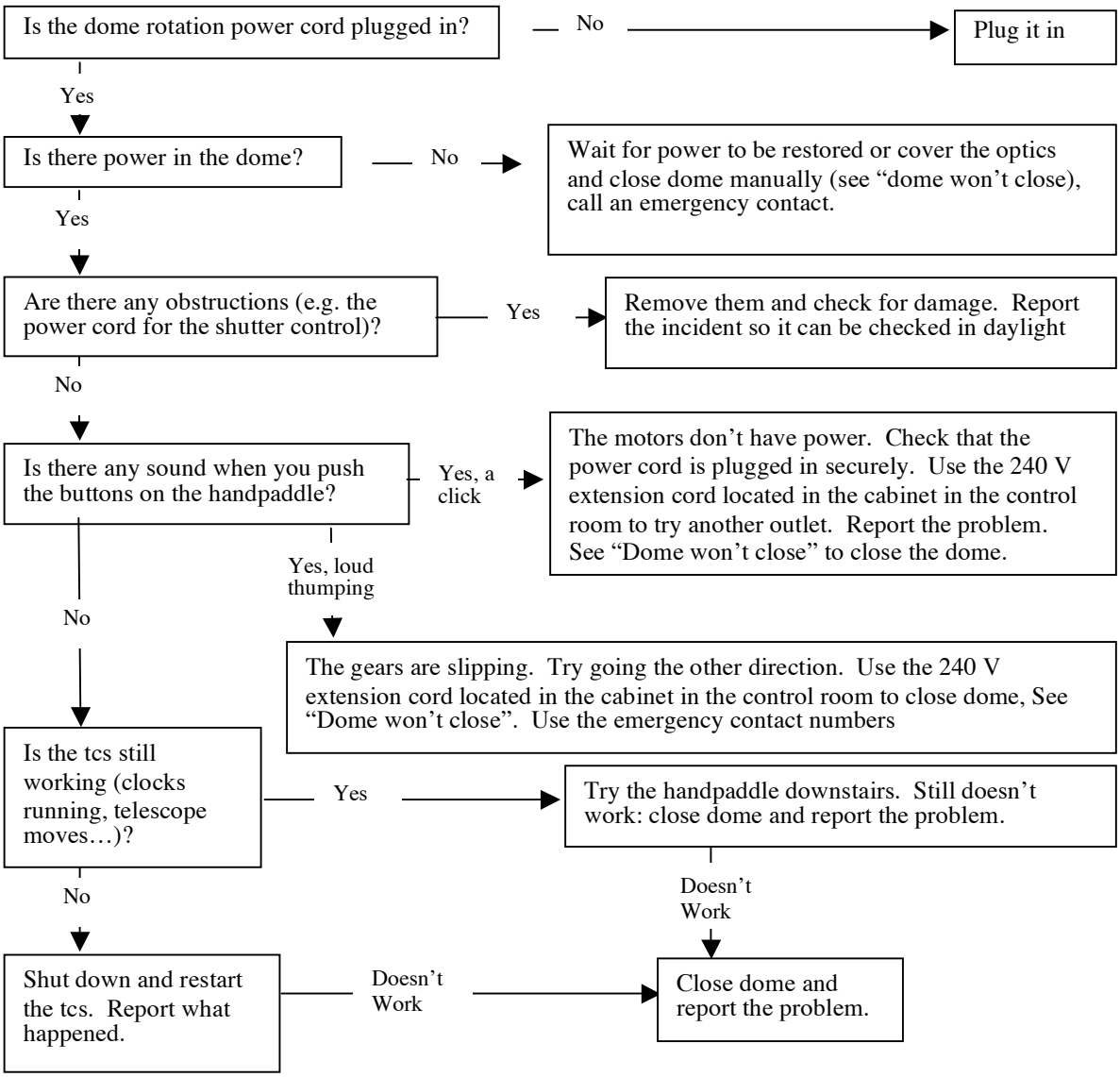
2. Select item 3 from the movement menu.
3. Enter the number of your chosen library object.
4. Answer "No" to "Any Changes?".
5. The coordinates of your library object should appear on the "Next Object" line and 'SLEW ENABLED" should blink at the bottom of the screen. If "Target out of Range" appears on the screen, the object is outside the pointing limits of the telescope. Press <esc> and go back to step 1 and choose a different object.
6. To cancel your selection press <esc> any time before slewing the telescope.
7. Select item 7 "Start Slew" and press <Enter> to slew to the object.

Troubleshooting

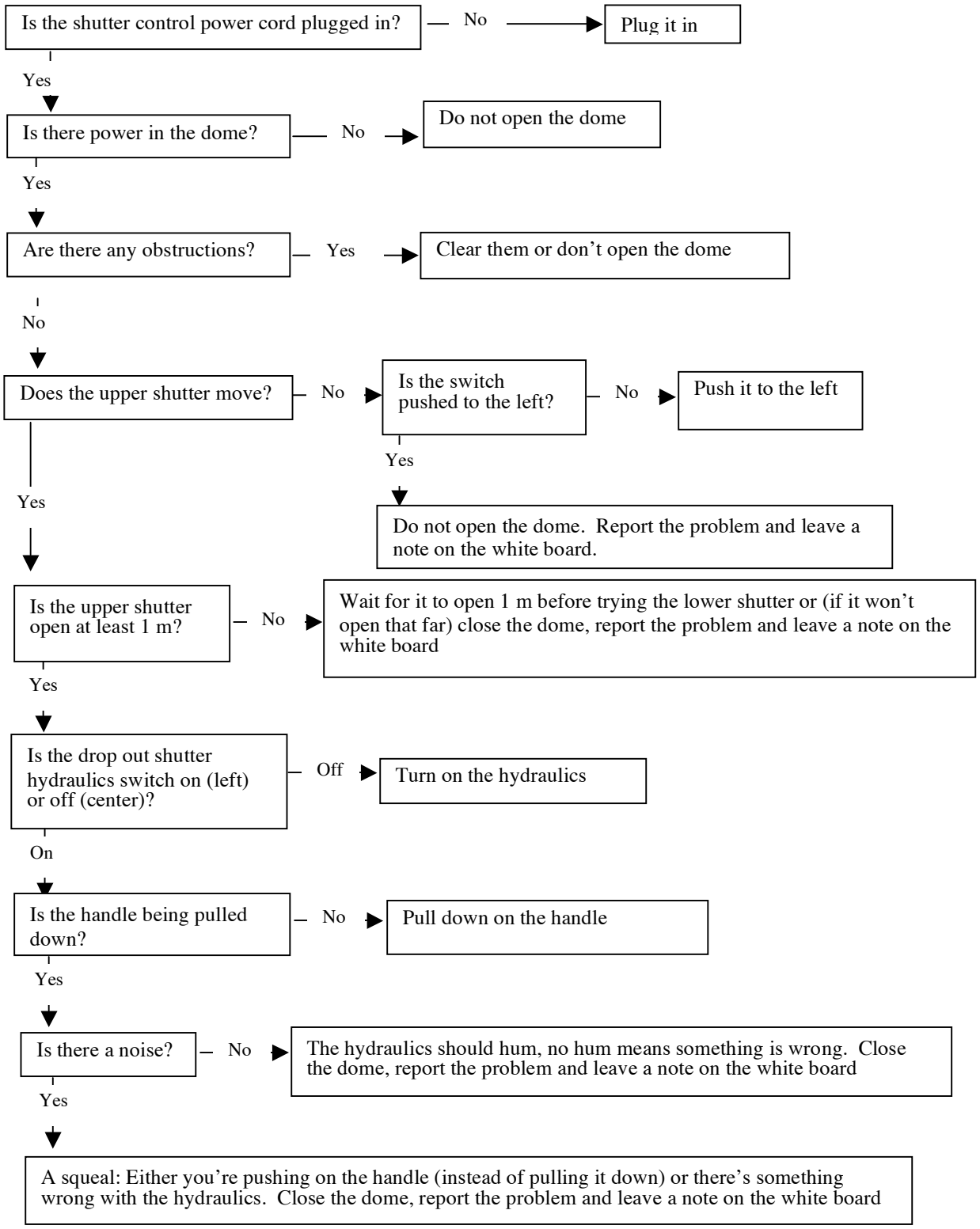
If you have any trouble that you cannot completely resolve, report the problem via the web or email (see "Reporting Trouble" on the last page) and leave a note on the white board so others aren't surprised if they encounter the same problem. If it is an urgent issue such as being unable to get the telescope upright or unable to close the dome, please do not leave until you have gotten hold of someone from the emergency contacts list.

Issues With the Dome

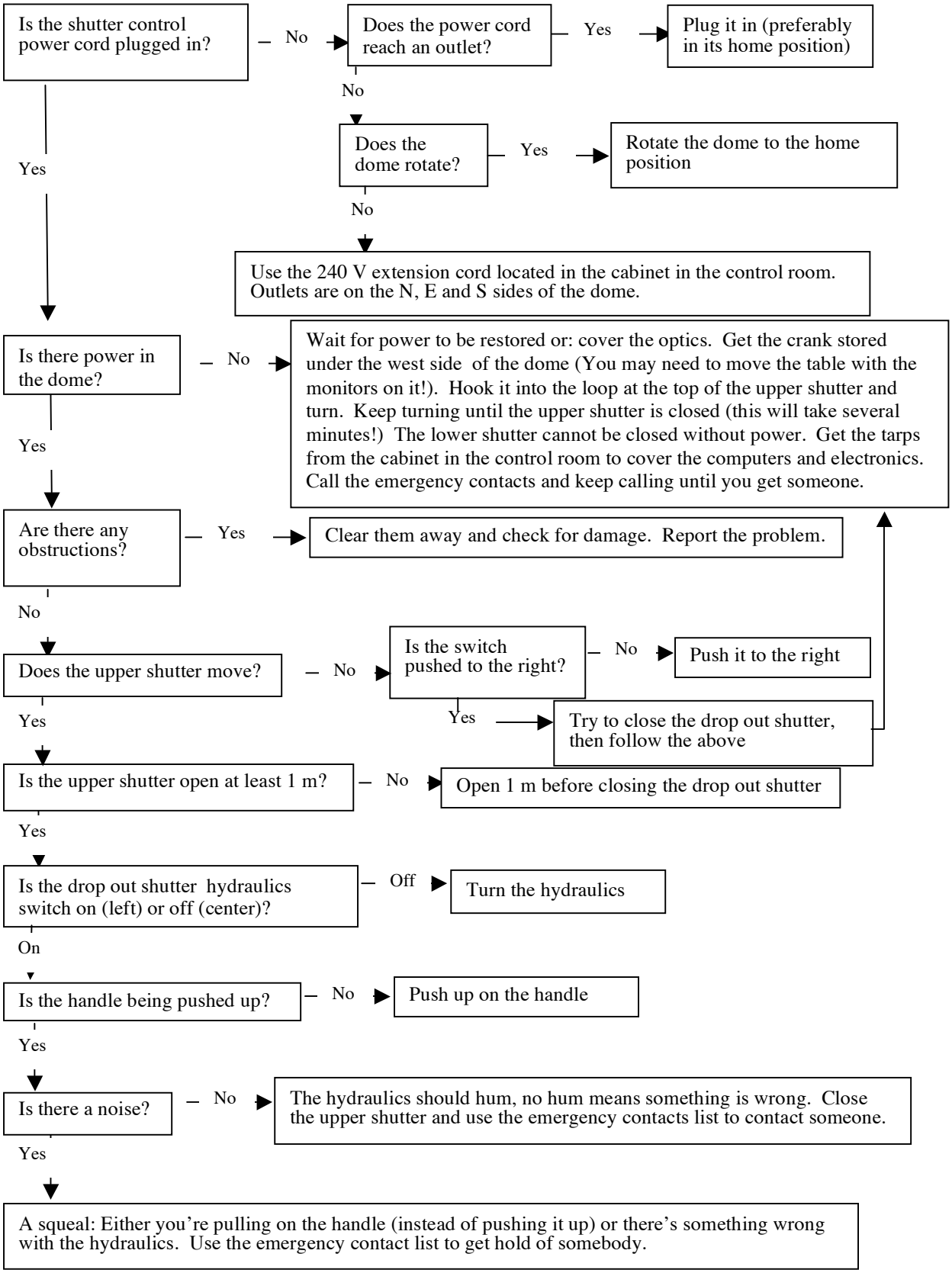
Dome won't rotate



Dome won't open

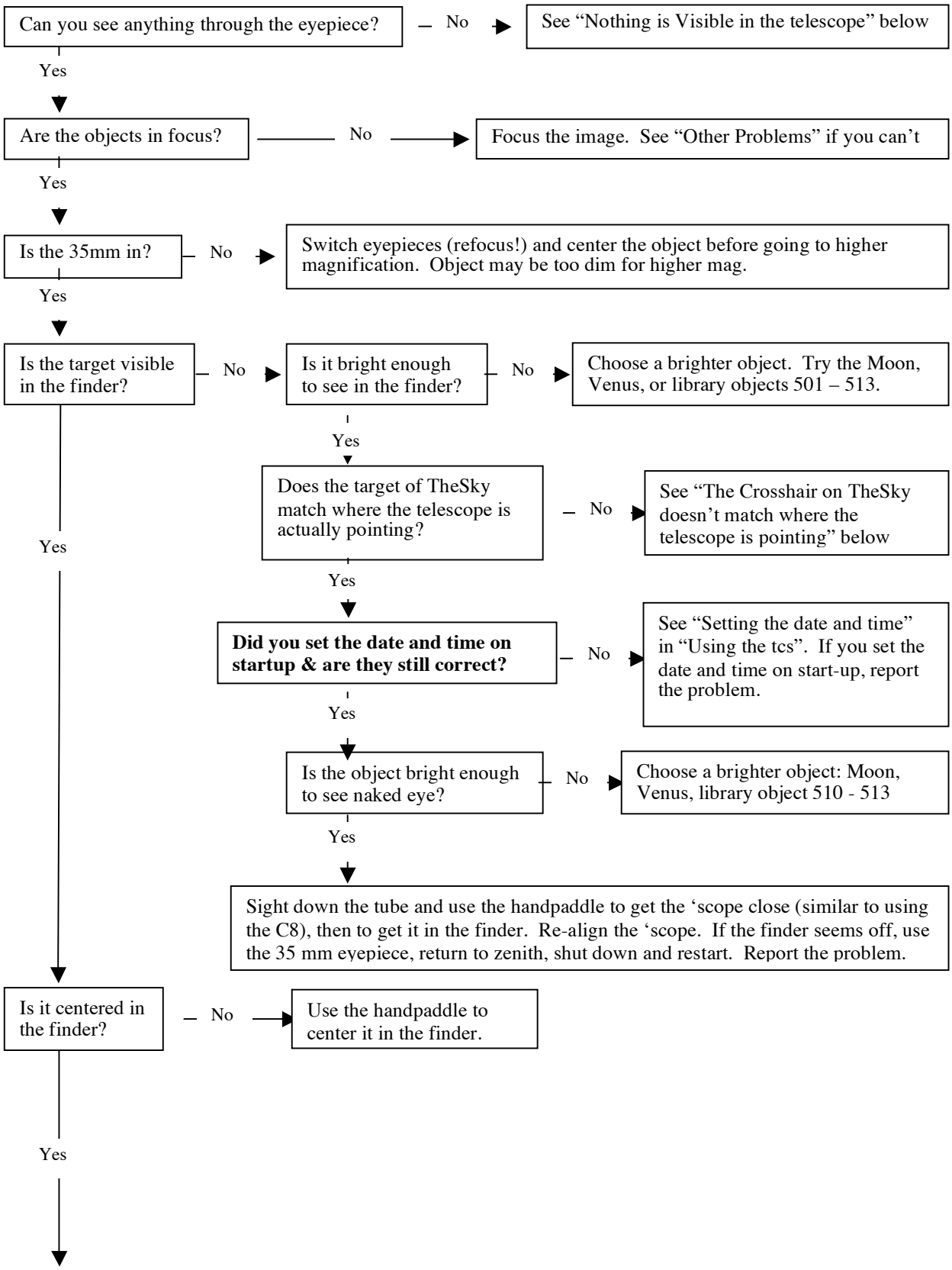


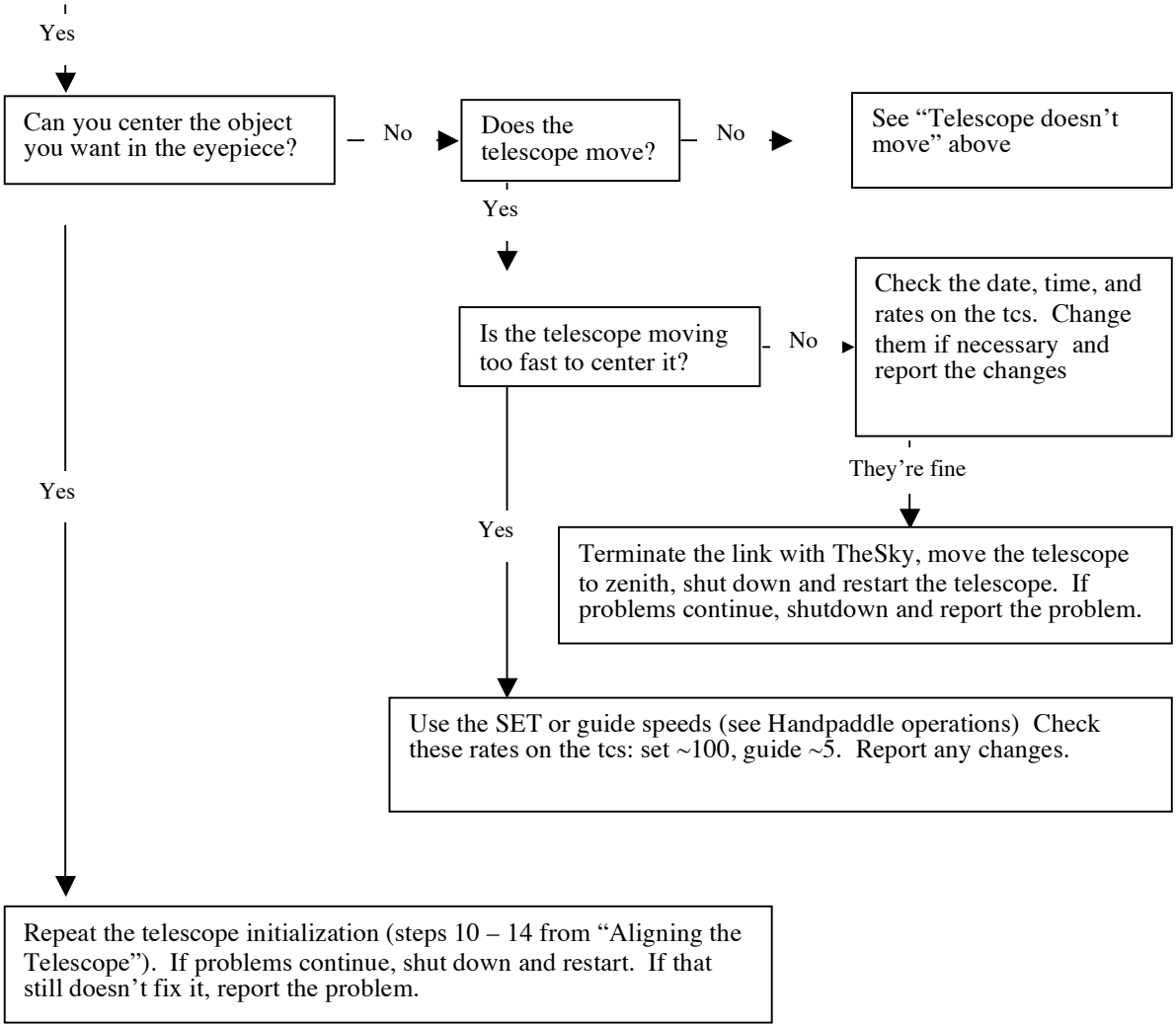
Dome won't close



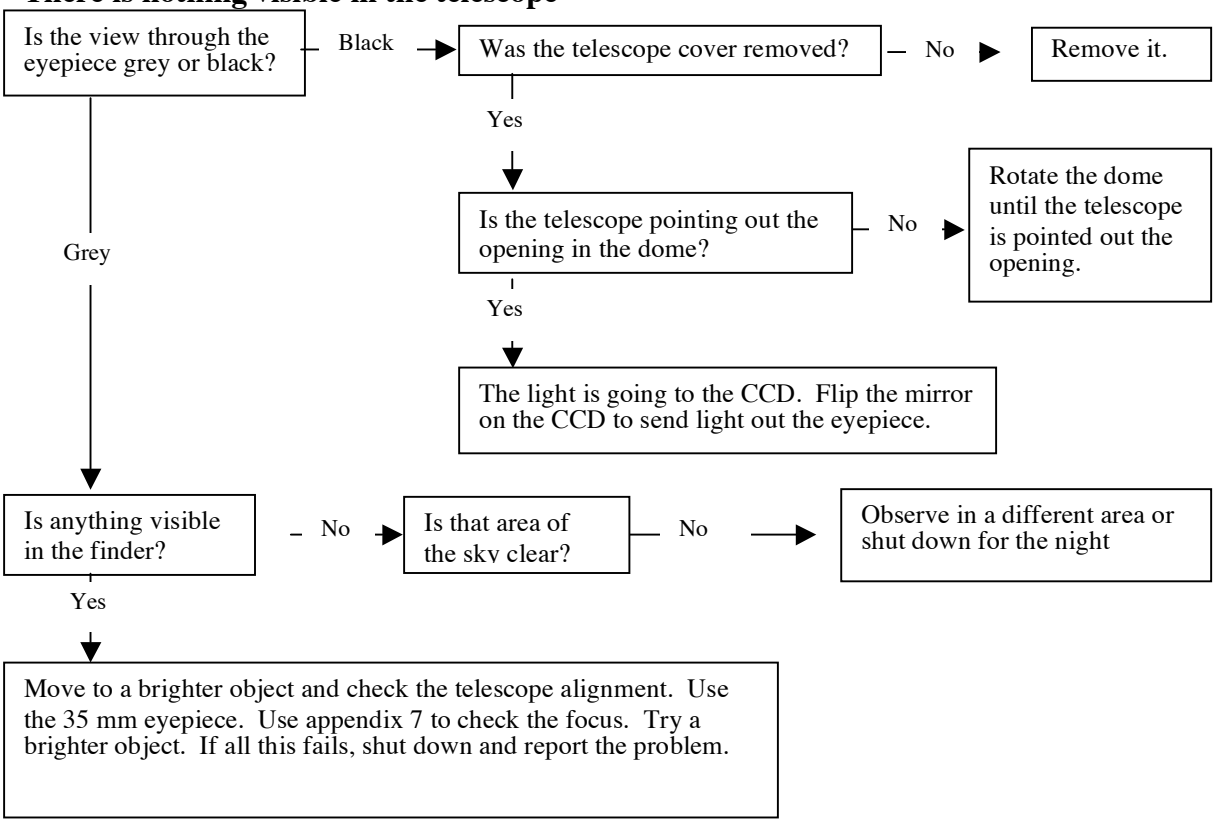
Telescope Pointing Problems

The target is not in the field of view of the main telescope

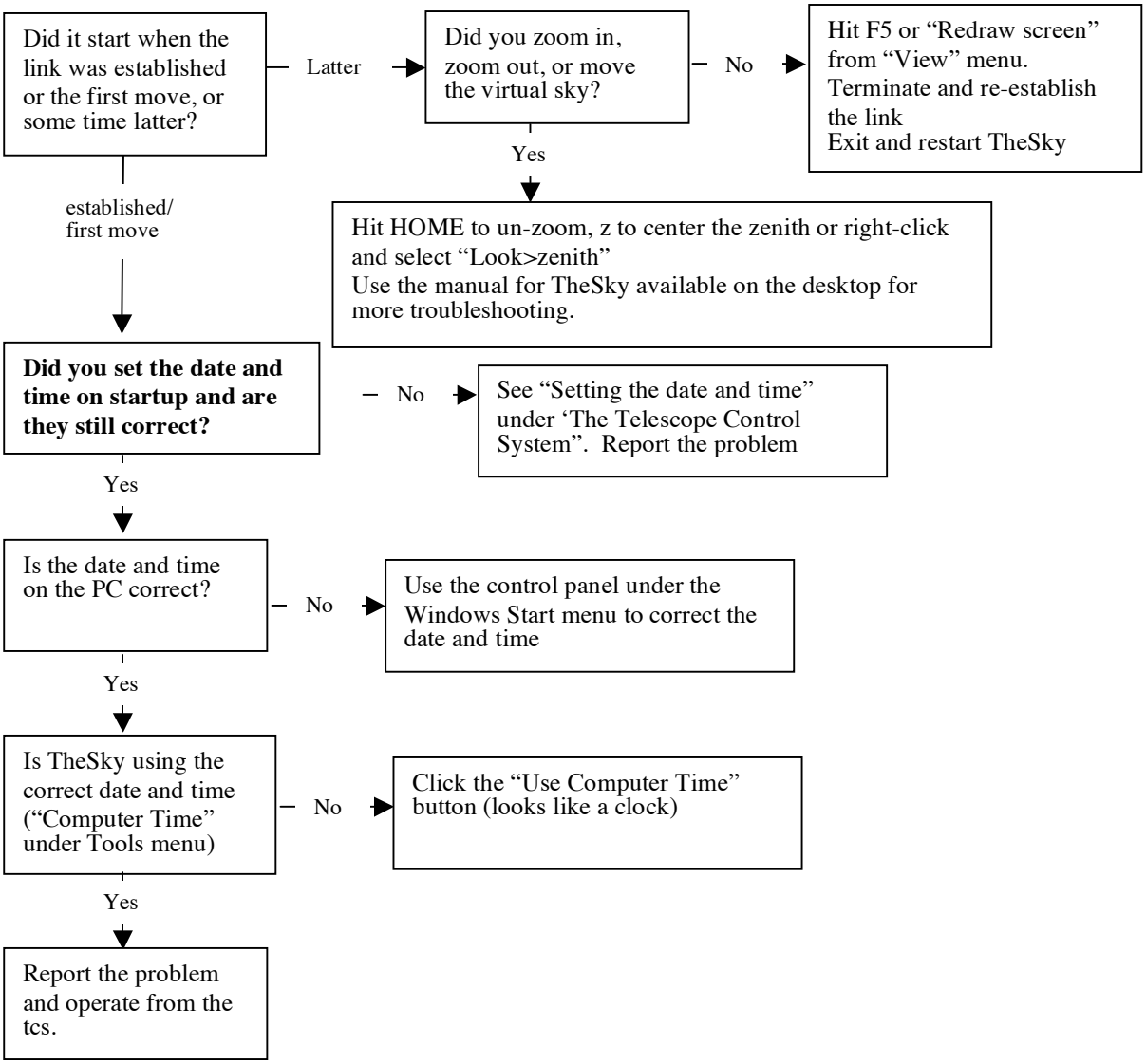



Yes
Can you center the object you want in the eyepiece?
No
Does the telescope move?
No
See "Telescope doesn't move" above
Yes
Is the telescope moving too fast to center it?
No
Check the date, time, and rates on the tcs. Change them if necessary and report the changes
They're fine
Yes
Yes
Terminate the link with TheSky, move the telescope to zenith, shut down and restart the telescope. If problems continue, shutdown and report the problem.
Use the SET or guide speeds (see Handpaddle operations) Check these rates on the tcs: set ~100, guide ~5. Report any changes.
Repeat the telescope initialization (steps 10 – 14 from "Aligning the Telescope"). If problems continue, shut down and restart. If that still doesn't fix it, report the problem.

There is nothing visible in the telescope

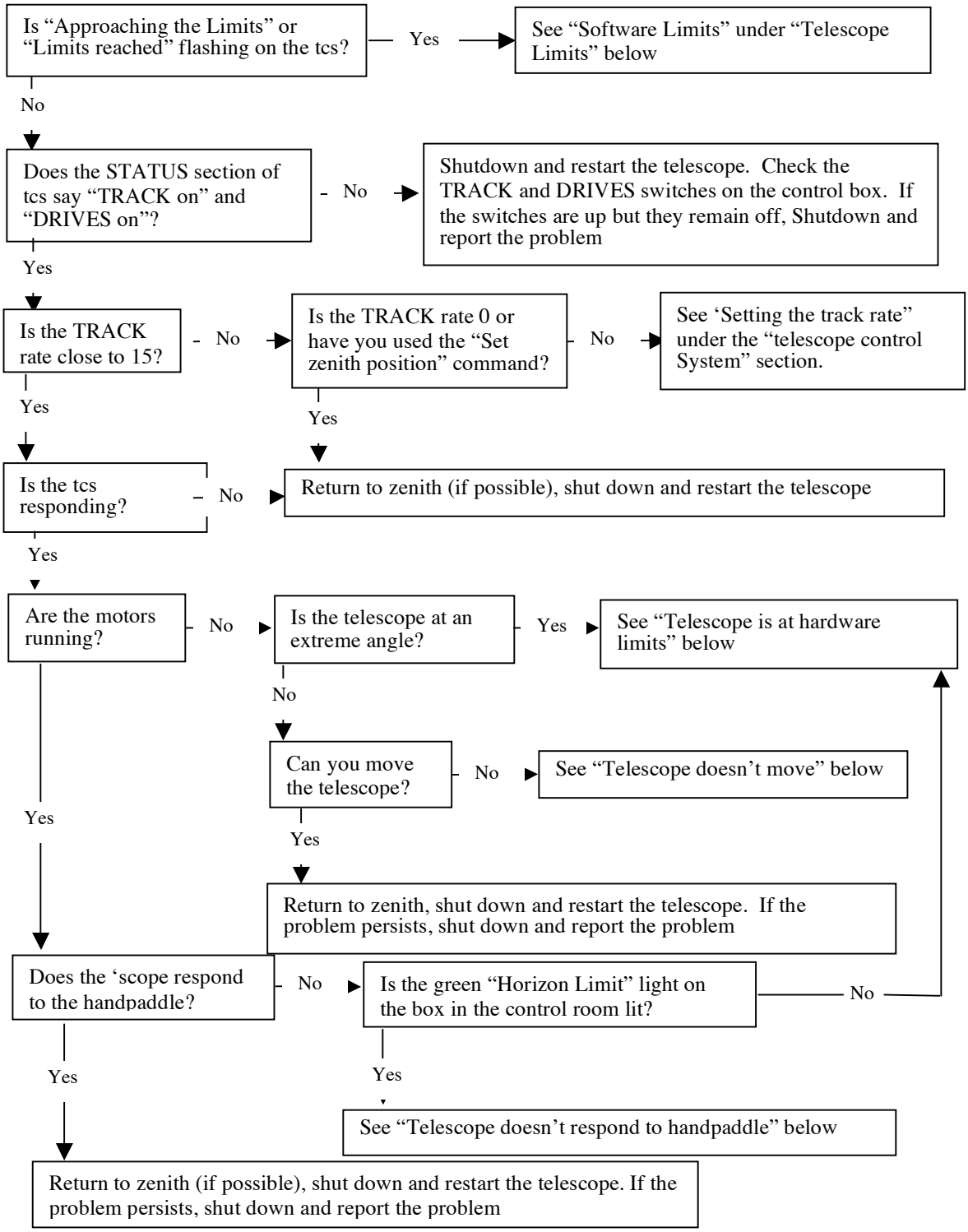


The crosshair on TheSky does not match where the telescope is pointing

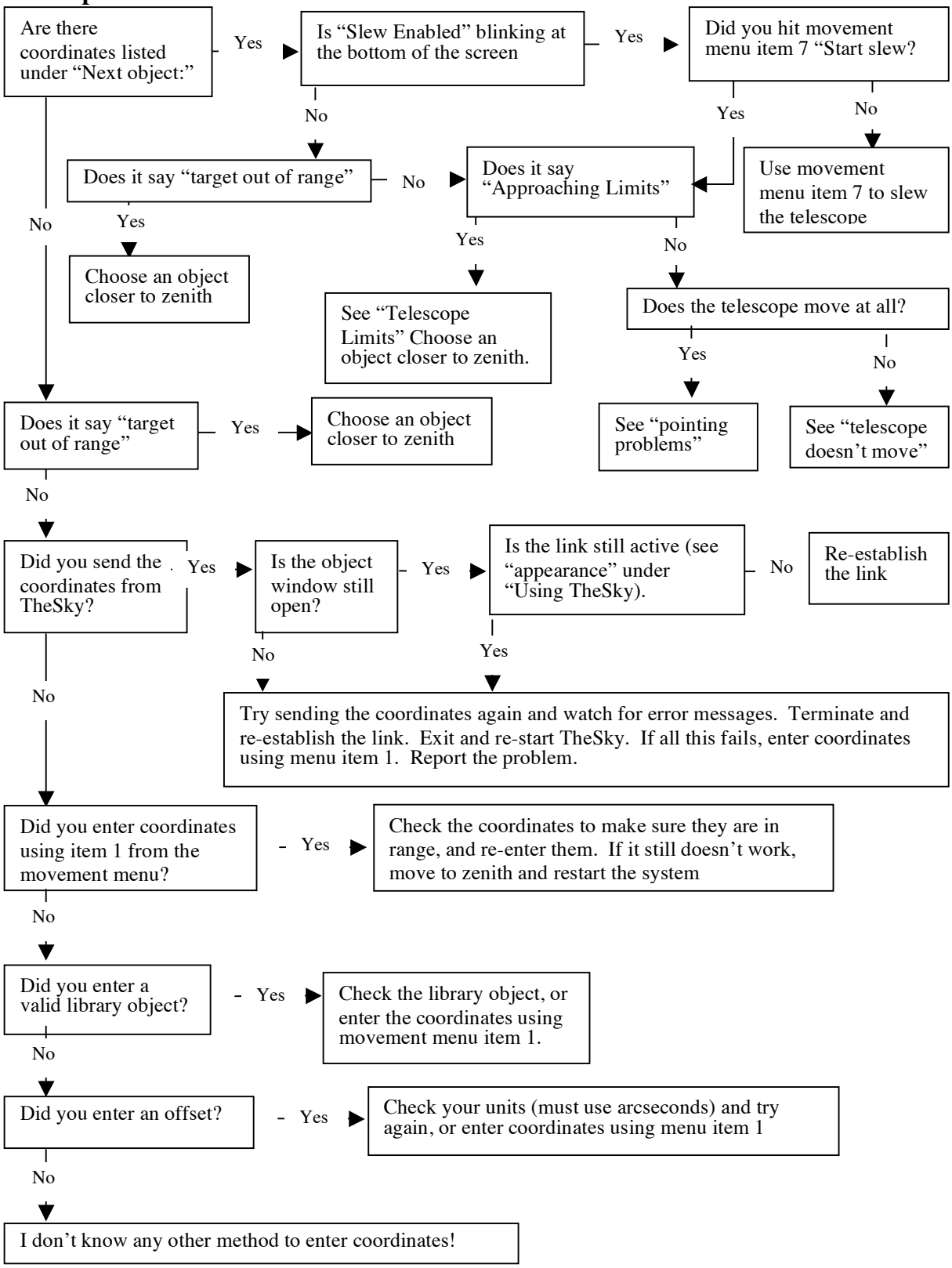


Problems With Telescope Motions

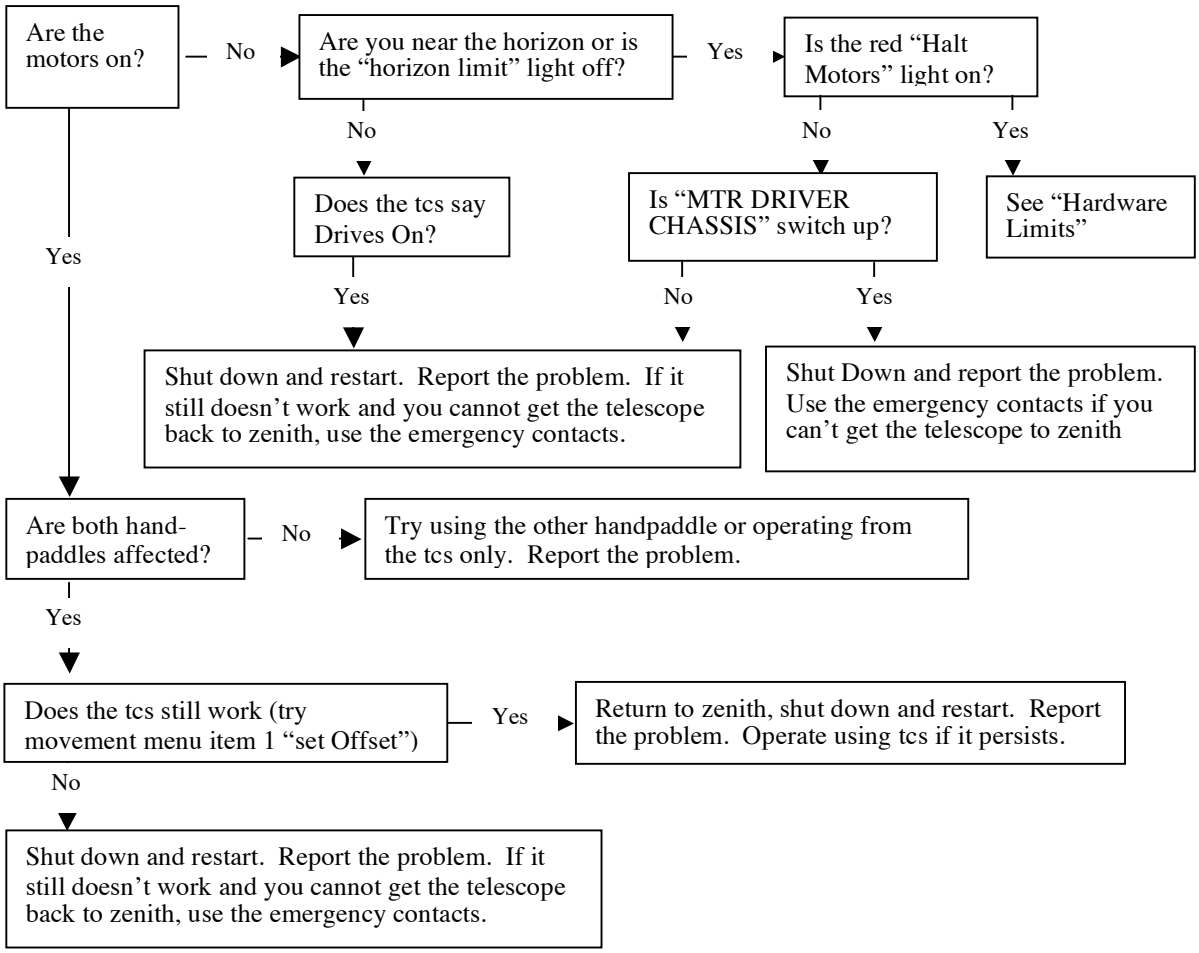
Telescope isn't tracking



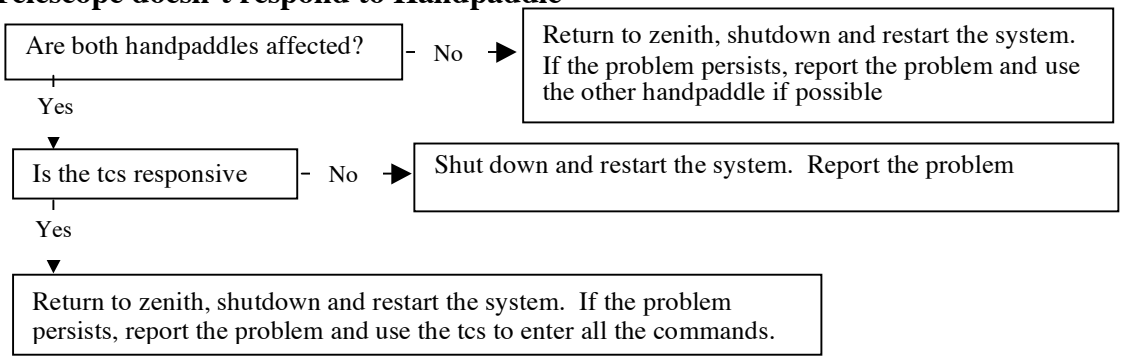
Telescope doesn't slew to new coordinates



Telescope Doesn't Move



Telescope doesn't respond to Handpaddle



Telescope limits

If you check the date and time on startup, restrict yourself to things on TheSky screen and don't zoom out, you shouldn't have a problem. The limits are roughly +47º to –32º dec and the sidereal time ± 5h RA.

Software limits

Note there are **no software limits** under the pole, so you should avoid moving the telescope low in the north!

As you approach the software limits, "APPROACHING LIMITS" flashes on the tcs screen. If the telescope is slewing

1. Release the handpaddle buttons or use movement menu item 8 "Stop" to stop the telescope from slewing.

The 'scope will be restricted to set and guide speeds. Once you hit the limits, "LIMIT REACHED" will flash below "APPROACHING LIMITS", the telescope will not move any farther in that direction, and it will only move at half speed. To get out of the limits:

1. Looking at the position of the telescope or the white target on TheSky determine the best way to get the telescope pointed closer to zenith.
2. Hold SLEW and the appropriate direction button on the handpaddle to move the 'scope toward zenith. You can only move one direction at a time, so you may have to move the 'scope in steps.
3. Once you clear the software limits, "APPROACHING LIMITS" stops blinking. Release the handpaddle, and resume normal operation. Note the rates don't go back to normal until you release the handpaddle.

Hardware Limits

Although the software limits make this nearly impossible, you could hit the **Hardware limits**. The most common reasons this occurs are slewing to the north when removing the cover, and not checking the date and time on startup. Additionally, if you shut down the telescope while it is in the software limits, it may start back up as if you had hit the hardware limits.

If you hit the hardware limits, the motors will shut off, the TRACK and DRIVES rates on the tcs screen will be zero and the green light on the front of the box in the control room will be off.

Always report when you hit the hardware limits since the drive belts need to be checked whenever the telescope is moved by hand.

To get out of the limits:

1. In the control room, push in red HALT MOTORS button.
2. Back in the dome, push front end of scope ~0.5" toward zenith by hand.
3. In the control room again, release red HALT MOTORS button. The green light should come on and the motors should be audible in the dome. If not, depress button and move 'scope again.

4. DO NOT move the telescope more than 2 - 3 inches (5 – 7 am). Use the emergency contact list to get hold of someone for help! Do not leave the telescope sideways.
5. Use movement menu item 5 to go to the zenith position, then use the handpaddle and levels to actually move the telescope to the zenith. Shut down and restart the telescope.
6. Report the problem.

Other Problems

Can't focus the image

Use the table in the appendix to get the focus close for your eyepiece. If that doesn't help, try changing eyepieces and refocusing. If the handpaddle isn't working, use Miscellaneous menu item 4. Remember there is about a 2 second lag when changing direction.

(Windows) PC Problems

The terminal you're at doesn't work, but the other one did

Make sure the monitor is turned on.

Check the main KVM box in the control room: both lights should be lit. If not, report the problem and reset the KVM: unplug the box that isn't working, count to 5 and pulg it back in.

If resetting the KVM doesn't work or you don't want to play with it, work without the PC and report the problem and the steps you tried to fix it.

If the PC won't boot:

Check the white board for messages

Make sure the power strip and monitor are on and the power cords are plugged in.

Either email astro-labs or use the web form to report that the computer won't boot (use the lab macs)

If you can't log in:

Check the white board for messages.

Check the user name and password on the bulletin board (remember, this is NOT your uniqname!)

Check the domain (should be "this computer")

If you're sure you're typing it in right and have the right domain, and either email astro-labs or use the web form to report that the computer won't let you in.

TheSky won't link to the tcs

Make sure the tcs is on and the telescope is running

Note any error messages and either email astro-labs or use the web form to report that you can't link to the telescope.

Use the info window in TheSky to get the RA and dec, then enter the coordinates through the tcs (see "Controlling the Telescope Without TheSky")

Appendix 1: Taking Images With the CCD Camera

This information is provided as a quick reference only for operators already familiar with the camera and CCD imaging. The CCDSoft manual is on the desktop, and there are several hardcopies of the manual for the previous version.

Note the camera is designed for deep sky objects. Daylight images are difficult (e.g. Venus at sunset), and the telescope should NEVER be pointed at the Sun.

Turning the Camera On and Setting up

1. Start the CCDSoft program on the PC.
2. Turn on the power strip on the pier in the dome
3. Use the 35 mm lens to focus on an object (its focal length is close to the camera's)
4. Use the round knob above the camera aligned with the eyepiece to flip the mirror to send light into the camera. The view through the eyepiece should be black
5. If the "Camera Control" window isn't open, open it by choosing "setup" from the "camera" menu, or typing "Ctrl+W"
6. The camera and filter wheel should already be selected. If not, the appropriate settings are on the bulletin board over the PC.
7. Click "Connect" to connect to the camera. If you get a "SBIG driver: Camera not found" the power strip is not on. Turn the power strip on and try again. If the power strip IS on, there is something wrong with the connection and you need to report the problem.
8. Click the "Temperature" button to get the temperature control window. Select the temperature setpoint (0º C is the default, -10º C is recommended) and click "On" to start the camera cooling.
9. Click the "AutoSave" tab and make sure autosave is turned on. The default file should be C:\Data.
10. When the temperature has reached the operating temperature, you are ready to start taking images.

Shutting Down

1. Save any work you want saved. C:\Data is a temp directory and is periodically cleaned out.
2. Click the "Temperature" button and turn off cooling.
3. Click the "Disconnect" button to disconnect from the camera.
4. Turn off the power strip
5. Flip the mirror so the light goes out the eyepiece.
6. Exit CCDSoft.

Capturing the Image

The camera is an SBIG ST-8 with a Kodak CCD. The chip has 9 micron square pixels in a 1530X1020 arrangement. The telescope scale is 53.4”/mm, and the field of view is 14.55x9.7”

1. Click the “Take Image” tab.
2. Set your exposure time.
3. If you want a delay, set the delay time.
4. If you want more than one image of the same object with the same exposure, choose a number from the dropdown list next to “Series of:”
5. Choose the filter you want to use: B, V, R, I or Halpha. You’ll have give the camera a moment to change the filter.
6. Choose whether you want the frame to be light, Bias, Dark, or a flatfield. If you do a light frame, choose what kind of reduction you want from the drop down list (note we do not have a screen at this time.)
7. When you are ready, click “Take Image”
8. The image will open in the CCDSoft window. You can edit it in that window, or export it to your own folder to edit latter.
9. If you want to take a subframe, draw a square around that area you want to take the subframe of, click “On” and set the bin size:

Binning factor	Pixel Size (“)	Readout time (sec)
1	0.57	58
2	1.14	19
3	1.71	11

10. To focus:
    a. set an appropriate exposure time and take a single exposure
    b. click the autosave tab and turn off autosave
    c. draw a box around a star in the field from the first image
    d. click the focus tab, make sure the subframe and binning are correct and click “take image”
    e. adjust the focus (you’ll probably need to use the handpaddle) until your image looks good and the sharpness graph is at its maximum.
    f. Turn autosave back on before going back to the “take image” tab.

Appendix 2: Binoculars

There are several pairs of binoculars available in the cabinet in the control room. Because binoculars are easy to walk off with, we've developed a procedure for using these in a class so that we don't loose them (again).

1. Decide how many you want to take out and find that number of responsible students
2. Get the students drivers licenses or state issued ID (they need it more than their college ID and it is illegal to take a credit card or similar item)
3. Place the first license in the card wallet section "1". Give that student binocular #1. Make it clear to that student that (s)he is responsible for that pair of binoculars.
4. Place the second license in section 2 and give that student binocular #2 along with the responsibility warning, the third in section 3, etc.
5. Record the binocular use on the paper inside the door of the cabinet.
6. At the end of the observing session, give the students their IDs only after you get back the binoculars you loaned to them.
7. Report any missing binoculars along with the full name of the student responsible for them to the angel hall trouble report (via web form or email) and to the professor in charge of the lecture section (unless it was for Ast 127)

A note on personal use of binoculars: we would rather have the binoculars used and cared for than collecting dust. However, labs get first priority, so do not take the binoculars on a lab night if there is **any** possibility of them being used for class, and do not take them off campus for an extended period. You become personally liable for any binoculars that go missing or are damaged while in your possession. If labs ever have any problems with not having enough binoculars, this policy will change.

Make sure you sign out the binoculars on the sheet inside the cabinet door. Binoculars which are not signed out will be reported stolen!

Appendix 3: C8 use and care

Used properly, the C8s are excellent 'scopes (and in windy, hot or cold weather may offer better views than the 0.4-m!) Be careful not to over-tighten the RA lock: it should be snug, but it will not prevent you from forcing the 'scope to move.
The Outreach 'scope in the control room can be taken into the classrooms or borrowed for outreach events by emailing astro-outreach or filling out the form on the astronomy department outreach page about the event and following the directions on the paper over the telescope.

Setting up

1. The RA lock should be unlocked for storage. Lock it before taking it out of the locker. Hold the C8 by the arms when moving it around. Carry it by the arm that does NOT have the dec lock (so you don't bend the dec lock rod).
2. Take the C8, power cord and eyepiece case out to the roof deck. You may or may not want the flashlight and a step stool.
3. Set the C8 on its side on the ground.
4. Locate the mounting bolts in the eyepiece case.
5. Screw one of the mounting bolts 2 - 6 turns into the **top** bolt hole (the one above the two motors, not beside them)
6. Place the other 2 bolts on the pier in easy reach when you get the 'scope up there.
7. Hold the telescope by the arms and slip the bolt into the open notch on the wedge. It is easiest to see what you're doing from the south side of the pier, but you'll have better leverage and control of the 'scope from the north side.
8. Keep one arm under the 'scope at all times in case the top bolt slips.
9. Rotate the scope until the other holes in the base of the scope line up with the wedge, and insert the other 2 bolts.
10. Tighten down all 3 bolts.
11. Remove the eyepiece cap and insert the diagonal. Make sure all the set screws are tightened (some 'scopes have 1, some have 2)
12. Insert the 40mm eyepiece in the diagonal and tighten the set screw.
13. Remove the blue lens cover and tuck it and the eyepiece cap into the lens case. Release the dec lock and the RA lock.
14. Center the telescope on a terrestrial object like the flag on top of the union and lock the dec lock and RA lock. IMPORTANT: the RA lock is locked when it is snug but not tight. It will NOT prevent you from moving the telescope by hand, but the 'scope should not move when nudged. The fine adjustment knob should move easily. Tightening it too far will strain the motors and warp the lock plate, preventing the telescope from locking at all.

15. Check the finder for alignment. If the finder isn't aligned with the main 'scope, adjust the set screws on the finder to bring it into alignment. The more precisely you perform this step, the easier the rest of your night will go!
16. Plug in the power cord.

Shutting Down

1. Unplug the power cord and replace the blue lens cover.
2. Release the set screws and remove the eyepiece and diagonal. Stow them in the lens case and put the eyepiece cap in the telescope.
3. Release the dec and RA locks and move the telescope to its storage position (tube aligned with arms, dec lock on east side, finder on top). Engage the RA and dec locks again.
4. Place one arm under the telescope just in case anything happens. Remove the two bottom bolts and set them on top of the pier.
5. Loosen the top bolt 2 or 3 turns. Hold the C8 by both arms and lift to slide the bolt out of the slot.
6. Set the C8 on the ground and remove the bolt. Stow all 3 bolts in one of the eyepiece holes in the eyepiece box. DO NOT LEAVE THEM LOOSE IN THE SECTION WITH THE DIAGONAL.
7. Place the C8 in its locker.
8. Release the RA lock.
9. Place the eyepiece case, power cord and flashlight in with their C8 (different 'scopes have different power cords and bolts, so make sure the telescope, case and power cord all go into the right locker!)

Night Observing

Naked eye objects

1. Identify the object in the sky
2. Release the RA and dec locks so you can move the 'scope.
3. Close one eye and sight down the tube to get the 'scope aimed in generally the right direction
4. Center the object in the finder. When it is close to centered, lock the RA and dec locks.
    a. When the RA lock is locked it should feel snug, but may not be as far as you can move it. In the locked position you should not be able to nudge the 'scope out of place, though you can force it to move. The fine adjustment knob should turn easily and the motors should not strain. TIGHTENING THE RA LOCK TOO FAR CAN WARP THE PLATE INSIDE AND PUT STRAIN ON THE MOTORS! The

‘scope may not track right, and repeatedly tightening the lock to far will warp the plate, at which point it won’t lock properly no matter how far you move the lever.

b. If you have any trouble with either the RA or dec locks, especially if they don’t tighten or hold properly, please report the problem. Be sure to note the telescope’s number.

5. Use the fine adjustment knobs to center the object in the finder ‘scope
6. Check the position in the 40 mm eyepiece. Use the fine adjustment knobs to center it if necessary.
7. The focus knob is on the back near the eyepiece on the side opposite the dec lock. Turning it clockwise moves the focus out for longer focal length eyepieces.
8. Work you way up to shorter focal length (higher magnification) eyepieces, re-centering and refocusing each time to avoid loosing the object.

Dimmer objects

1. Determine the RA and dec of your target
2. Find a nearby bright object with the same dec as the object you want to find
3. Center the bright object in the finder and in the 40 mm eyepiece. Lock both the RA and dec.
4. Move the setting circle on the base of the telescope until it reads the right RA. There is a scale under the RA lock to do this.
5. Release the RA lock and move the ‘scope to the RA of your target.
6. If the target is bright enough, center it in the finder ‘scope. Otherwise, you may have to do some hunting with the 40 mm eyepiece. Note that since the wedges are not perfect (hence the dec alignment is not perfect) it is not recommend that you try to view anything you can’t see in the 40mm.

Solar Observing

White Light Filter

1. Make sure the telescope you use has a cover on the FRONT of the finder. DO NOT try to rig a cover, or use a telescope without the cover.
2. Follow all the steps to set up the C8 EXCEPT do not align the finder. Leave the finder covered at all times.
3. Point the telescope AWAY from the Sun.
4. Fit the reflective white light filter over the front end of the telescope. Be careful not to catch the foam tabs on the rim of the telescope as you put the filter on. Make sure the filter is on all the way and is secure.
5. Use the telescope's shadow to align it. The shadow of the finder is the easiest to use: the shadow should be a dark circle (the finder 'scope) inside a dark ring (the holder for the finder 'scope) with a light band all the way around except where the screws go through.
6. Use the 40 mm eyepiece to get the Sun in the telescope. Then you can switch to a higher magnification eyepiece to observe sunspot regions.

H alpha filter

The H alpha filter needs about an hour to warm up for good images. You may want to plug the filter in ahead of time so it will be ready when you are.

1. Make sure the telescope you use has a cover on the FRONT of the finder. DO NOT try to rig a cover, or use a telescope without the cover.
2. Follow all the steps to set up the C8 EXCEPT do not align the finder. Leave the finder covered at all times. You should also wait to put the diagonal and eyepiece in.
3. Point the telescope away from the Sun
4. Fit the red aperture stop filter over the front end of the telescope. Be careful not to catch the foam tabs on the rim of the telescope as you put the filter on. Make sure the filter is on all the way and is secure.
5. Remove the visual back (the black thing the diagonal goes in) by unscrewing it from the tube.
6. Screw the visual back attached to the H alpha filter onto the telescope.
7. Plug in the H alpha filter (if you didn't do that an hour ago). Please make sure the cord is wrapped around the pier and out of the way.
8. Insert the diagonal and eyepiece.
7. Use the telescope's shadow to align it. The shadow of the finder is the easiest to use: the shadow should be a dark circle (the finder 'scope) inside a dark ring (the

holder for the finder ‘scope) with a light band all the way around except where the screws go through.

8. Use the 40 mm eyepiece to get the Sun in the telescope. Then you can switch to a higher magnification eyepiece to observe sunspot regions.
9. Adjusting the settings on the filter thermostat will alter the temperature of the filter, changing the wavelength it is sensitive to. This changes the height in the chromosphere you’re viewing. Each time a change is made, it takes several minutes for the filter to adjust.
10. To improve the view:
    a. Make sure the filter is plugged in for half an hour minimum on a warm day, longer for colder days
    b. You may want to adjust the temperature to try and get a better view, but give it at least 2 minutes to adjust to your changes
    c. The filter may be damaged in places from improper use and storage. Rotating the aperture stop can change the area of the filter getting the most light and so avoid the damaged areas.

Appendix 4: History

The Observatory on the roof of Angell Hall is the latest in a series of facilities at the University of Michigan to instruct students in observational astronomy. The first Students' Observatory was constructed in the late 1870's close to the Detroit Observatory, and had a 6" refractor on an equatorial mount and a 3" transit circle. Optics for both were supplied by the Clarks. The building was torn down in 1923, and the mount for the refracting telescope was taken to South Africa to be used for site testing for the Lamont-Hussey Observatory. The 6" Clark lens later was used as a finder on the 27" Lamont refractor. The transit circle can still be seen in the Detroit Observatory.

During the 1920s a new observatory with two 24 foot diameter copper domes was built on the roof of Angell Hall. The southern dome housed a 10" refractor built by Warner and Swasey. The northern dome had a 15" Cassegrain reflector. Both were on equatorial mounts. These instruments were removed in the fall of 1993 during a complete renovation of Angell Hall.

Appendix 5: Telescope Description

The current telescope was manufactured by DFM Engineering of Longmont, CO., and installed on Angell Hall in December, 1994. It is a 0.4-m diameter F/8 reflecting telescope with full Ritchey-Chretien optics (including field corrector). The reflecting optics are of low expansion material. The telescope has a demonstrated pointing accuracy of better than 30" rms and is completely computer controlled. The 18' Ash Dome is controlled by the handpaddle.

Appendix 6: Comparison with other Michigan Telescopes

University of Michigan astronomers have access to four other telescopes at observatories in Arizona and Chile. Here are the principal differences from the 0.4-m in how these other telescopes are controlled:

Hiltner 2.4-m telescope at MDM, Arizona

The 0.4-m is very much a smaller version of the 2.4-m at Michigan-DartmouthMIT Observatory. Everything is under computer control, and one never sees the telescope while one is observing, as the observer sits in a comfortable control room. The TCS display is different than that of the 0.4-m, but all the same information is presented on the display.

McGraw-Hill 1.3-m telescope at MDM, Arizona

With this telescope, one does most of the observing from the control room. However, to slew the telescope to a new object, one must go out into the dome and press the appropriate direction buttons to drive the telescope to a new position.

Curtis Schmidt telescope at Cerro Tololo, Chile

There is no TCS system for this telescope. All motion of the telescope and dome is by hand. One pushes some buttons to release the brakes on the telescope, and then physically moves the telescope around the sky while one is watching the pointers on the setting circles. The dome is also controlled from a handpaddle in the dome. The CCD camera is controlled, however, from an observing room underneath the telescope. Thus one has quite a bit of exercise going up and own the stairs during the night. What fun!

Magellan 6.5-m telescopes, Las Campanas, Chile

These twin telescope are completely computer controlled on alt-az mounts. The operator will move the telescope, make sure it is tracking and guiding, and keep the optics aligned. You (the observer) will provide him or her with a list of the objects to be observed during the night. The observer controls the CCD camera and filters, but will not control the telescope.

Appendix 7: Technical Information for the 0.4-m

Location

Latitude N 42d 16' 37.8"
Longitude W 83d 44' 23.88"

Optical Characteristics

Both primary and secondary mirrors are of Corning ULE. The field corrector is a two element design and is not currently installed since we don't do any wide field observations.
The following information was provided by the manufacturer

Primary	
primary mirror diameter	406.4 mm
hole diameter	127.0 mm
radius	2438.4 mm
focal length	1219.2 mm
conic constant	-1.1245
primary f ratio	F/3
Secondary	
secondary mirror diameter	152.4 mm
radius	1197.1 mm
focal length	-598.4 mm
conic constant	-6.502
outside diameter of secondary baffle	202.4 mm
primary-secondary separation	836.5 mm
System	
system f ratio	F/8
focal length	3251.2 mm
plate scale	63.4 "/mm
unvignetted field diameter	75 mm 1.32 deg
back focal distance	84.2 mm

Pointing Limits

The telescope has a first software pointing limit of 75 degrees zenith distance, with a maximum allowable zenith distance of 80 degrees. The telescope will slew to 75 degrees, but within the range of 75 to 80 degrees zenith distance only set and guide motions are permitted. The limits are roughly +47º to –32º in dec and the sidereal time ± 5h in RA.

The telescope is protected from going too far by means of a mercury limit switch. If this switch is tripped at an extreme zenith distance, all power to the telescope is turned off and the green light on the control panel will be off. To recover from this, push the HALT MOTORS switch in, and gently push the telescope by hand towards the zenith until the green light comes on. Release the HALT MOTORS switch, and check the coordinates by finding a bright star.

Eyepieces

The following eyepieces are available

focal length	Magnification	field of view	focus with diagonal	focus w/o diagonal
35mm	91x	32’	1863	765
25mm	128x	24’	1751	653
15mm	213x	15’	1756	658
7.5mm	427x	7’	1748	650

The focus readings were noted at a temperature of 75 degrees F. At cooler temperatures the focus should be at lower numbers.

The eyepieces are stored in a black plastic storage container kept in the dome. If not there, check in the locked storage cabinet downstairs, or in one of the lockers in the dome. Please report misplaced eyepieces.

Appendix 8: Filters

All eyepieces are 1.25” diameter and screw onto the base of the eyepiece.

There is a lunar filter in each eyepiece case that has a 13% transmission. Additional filters are kept in boxes in the cabinet in the control room. Please make sure filters go back into the correct box so others can find them:

Set	Filter # and Color	Uses	% transmission, Notes
Basic set	#80A Blue #58 Green #25 Red #15 Yellow	Great Red Spot, bands Martian polar caps and clouds, red features on Jupiter. Mars, blue Jupiter & Saturn clouds Moon	Worth using Best martian detail
Expansion set	#21 orange #47 violet #11 yellow-green #82 light blue	Jovian bands Venus, Martian polar caps Blue and red features on Jovian planets Jupiter’s atmosphere	Worth using Very dark Almost useless
Advanced set	#8 light yellow #23A light red #38A Deep Blue #56 light green	Low contrast dust and ice details (atmospheres, comet dust tails) Enhances contrast for daylight/twilight planets Very bright objects Moon, Jovian & Venusian atmospheres, Martian ice caps	83% 25% excellent for Mercury 17% 53% worth using
Filters in labs rooms	Skyglow Nebula/ ultrablock	Both reduce the glare from light pollution	Light pollution too bad for these to fix…

Appendix 9: Technical Information for the C8s

The following information was provided by the manufacturer

Primary mirror diameter	8”
System focal length	80” = 2032 mm
Secondary obstruction	2.75”
F ratio	f/10
Near focus	25’
Weight	23 lbs
Theoretical faintest magnitude	14.4
Theoretical resolution	0.5 arcsec

Appendix 10: The Messier Objects and their coordinates

Epoch 2000.

No	Name	m	Dist (kly)	Type	RA hh:mm.m	Dec dd:mm
1	Crab nebula	8.4	6.3	SN remnant	05 : 34.5	+22 : 01
2		6.5	37.5	Globular cluster	21 : 33.5	-00 : 49
3		6.2	33.9	Globular cluster	13 : 42.2	+28 : 23
4		5.6	7.2	Globular cluster	16 : 23.6	-26 : 32
5		5.6	24.5	Globular cluster	15 : 18.6	+02 : 05
6	Butterfly cluster	4.2	1.6	Open cluster	17 : 40.1	-32 : 13
7	Scorpion’s tail	3.3	0.8	Open cluster	17 : 53.9	-34 : 49
8	Lagoon nebula	6.0	5.2	Diffuse nebula	18 : 03.8	-24 : 23
9		7.7	25.8	Globular cluster	17 : 19.2	-18 : 31
10		6.6	14.3	Globular cluster	16 : 57.1	-04 : 06
11	Wild duck cluster	6.3	6	Open cluster	18 : 51.1	-06 : 16
12		6.7	16	Globular cluster	16 : 47.2	-01 : 57
13	Hercules	5.8	25.1	Globular cluster	16 : 41.7	+36 : 28
14		7.6	30.3	Globular cluster	17 : 37.6	-03 : 15
15		6.2	33.6	Globular cluster	21 : 30.0	+12 : 10
16		6.4	7	Open cluster	18 : 18.8	-13 : 47
17	Omega, swan, horseshoe or lobster	6	5	Diffuse nebula	18 : 20.8	-16 : 11
18		7.5	4.9	Open cluster	18 : 19.9	-17 : 08
19		6.8	28	Globular cluster	17 : 02.6	-26 : 16
20	Trifid	9	5.2	Diffuse nebula	18 : 02.6	-23 : 02
21		6.5	4.25	Open cluster	18 : 04.6	-22 : 30
22		5.1	10.4	Globular cluster	18 : 36.4	-23 : 54
23		6.9	2.15	Open cluster	17 : 56.8	-19 : 01
24	Delle Caustiche	4.6	10	Patch in Milky Way	18 : 16.9	-18 : 29
25		6.5	2	Open cluster	18 : 31.6	-19 : 15
26		8	5	Open cluster	18 : 45.2	-09 : 24
27	Dumbell	7.4	1.25	Planetary Nebula	19 : 59.6	+22 : 43
28		6.8	18.3	Globular cluster	18 : 24.5	-24 : 52
29		7.1	4	Open cluster	20 : 23.9	+38 : 32
30		7.2	26.1	Globular cluster	21 : 40.4	-23 : 11
31	Andromeda Galaxy	3.4	2900	Sb galaxy	00 : 42.7	+41 : 16
32	Andromeda satellite	8.1	2900	E2 galaxy	00 : 42.7	+40 : 52
33	Triangulum galaxy	5.7	3000	Sc galaxy	01 : 33.9	+30 : 39
34		5.5	1.4	Open cluster	02 : 42.0	+42 : 47
35		5.3	2.8	Open cluster	06 : 08.9	+24 : 20
36		6.3	5.1	Open cluster	05 : 36.1	+34 : 08
37		6.2	4.4	Open cluster	05 : 52.4	+32 : 33
38		7.4	4.2	Open cluster	05 : 28.4	+35 : 50
39		4.6	.825	Open cluster	21 : 32.2	+48 : 26
40	Winnecke 4	8.4	.51	Double Star	12 : 22.4	+58 : 05

41		4.6	2.3	Open cluster	06 : 46.0	-20 : 44
42	Orion nebula	4.0	1.6	Diffuse nebula	05 : 35.4	-05 : 27
43	De Mairan's Nebula	9.0	1.6	Diffuse nebula	05 : 35.6	-05 : 16
44	Beehive Cluster, Praesepe	3.7	.577	Open cluster	08 : 40.1	+19 : 59
45	Pleiades	1.6	.38	Open cluster	03 : 47.0	+24 : 07
46		6.0	5.4	Open cluster	07 : 41.8	-14 : 49
47		5.2	1.6	Open cluster	07 : 36.6	-14 : 30
48		5.5	1.5	Open cluster	08 : 13.8	-05 : 48
49		8.4	60000	E4 galaxy	12 : 29.8	+08 : 00
50		6.3	3	Open cluster	07 : 03.2	-08 : 20
51	Whirlpool Galaxy	8.4	37000	Sc galaxy	13 : 29.9	+47 : 12
52		7.3	5	Open cluster	23 : 24.2	+61 : 35
53		7.6	58	Globular cluster	13 : 12.9	+18 : 10
54		7.6	87.4	Globular cluster	18 : 55.1	-30 : 29
55		6.3	17.3	Globular cluster	19 : 40.0	-30 : 58
56		8.3	32.9	Globular cluster	19 : 16.6	+30 : 11
57	Ring Nebula	8.8	2.3	Planetary nebula	18 : 53.6	+33 : 02
58		9.7	60000	Sbc galaxy	12 : 37.7	+11 : 49
59		9.6	60000	E5 galaxy	12 : 42.0	+11 : 39
60		8.8	60000	E2 galaxy	12 : 43.7	+11 : 33
61		9.7	60000	SABbc galaxy	12 : 21.9	+04 : 28
62		6.5	22.5	Globular cluster	17 : 01.2	-30 : 07
63	Sunflower galaxy	8.6	37000	Sb galaxy	13 : 15.8	+42 : 02
64	Black eye galaxy	8.5	19000	Sb galaxy	12 : 56.7	+21 : 41
65		9.3	35000	Sa galaxy	11 : 18.9	+13 : 05
66		8.9	35000	Sb galaxy	11 : 20.2	+12 : 59
67		6.1	2.7	Open cluster	08 : 50.4	+11 : 49
68		7.8	33.3	Globular cluster	12 : 39.5	-26 : 45
69		7.6	29.7	Globular cluster	18 : 31.4	-32 : 21
70		7.9	29.3	Globular cluster	18 : 43.2	-32 : 18
71		8.2	13	Globular cluster	19 : 53.8	+18 : 47
72		9.3	55.4	Globular cluster	20 : 53.5	-12 : 32
73		9	2	Asterism	20 : 58.9	-12 : 38
74		9.4	35000	Sc galaxy	01 : 36.7	+15 : 47
75		8.5	67.5	Globular cluster	20 : 06.1	-21 : 55
76	Little Dumbell	10.1	3.4	Planetary nebula	01 : 42.4	+51 : 34
77	Cetus A	8.9	60000	Sb galaxy	02 : 42.7	-00 : 01
78		8.3	1.6	Diffuse nebula	05 : 46.7	+00 : 03
79		7.7	42.1	Globular cluster	05 : 24.5	-24 : 33
80		7.3	32.6	Globular cluster	16 : 17.0	- 22 : 59
81	Bode’s galaxy	6.9	12000	Sb galaxy	09 : 55.6	+69 : 04
82	Cigar galaxy	8.4	12000	IrrII galaxy	09 : 55.8	+69 : 41
83	Southern pinwheel	7.6	15000	SABc galaxy	13 : 37.0	-29 : 52
84		9.1	60000	S0 galaxy	12 : 25.1	+12 : 53
85		9.1	60000	S0 galaxy	12 : 25.4	+18 : 11
86		8.9	60000	S0 galaxy	12 : 26.2	+12 : 57
87	Virgo A	8.6	60000	E1 galaxy	12 : 30.8	+12 : 24
88		9.6	60000	Sc galaxy	12 : 32.0	+14 : 25
89		9.8	60000	E0 galaxy	12 : 35.7	+12 : 33
90		9.5	60000	Sb galaxy	12 : 36.8	+13 : 10
91		10.2	60000	SBb galaxy	12 : 35.4	+14 : 30
92		6.4	26.7	Globular cluster	17 : 17.1	+43 : 08
93		6	3.6	Open cluster	07 : 44.6	-23 : 52
94		8.2	14500	Sb galaxy	12 : 50.9	+41 : 07
95		9.7	38000	SBb galaxy	10 : 44.0	+11 : 42
96		9.2	38000	Sa galaxy	10 : 46.8	+11 : 49
97	Owl nebula	9.9	2.6	Planetary nebula	11 : 14.8	+55 : 01
98		10.1	60000	Sb galaxy	12 : 13.8	+14 : 54
99		9.9	60000	Sc galaxy	12 : 18.8	+14 : 25
100		9.3	60000	Sc galaxy	12 : 22.9	+15 : 49

101	Pinwheel galaxy	7.9	27000	Sc galaxy	14 : 03.2	+54 : 21
102		?	?	Spiral galaxy?	?	?
103		7.4	8.5	Open cluster	01 : 33.2	+60 : 42
104	Sombrero galaxy	8.0	50000	Sa galaxy	12 : 40.0	-11 : 37
105		9.3	38000	E1 galaxy	10 : 47.8	+12 : 35
106		8.4	25000	Sb galaxy	12 : 19.0	+47 : 18
107		7.9	20.9	Globular Cluster	16 : 32.5	-13 : 03
108		10	45000	Sc galaxy	11 : 11.5	+55 : 40
109		9.8	55000	Sbc galaxy	11 : 57.6	+53 : 23
110		8.5	2900	E6 galaxy	00 : 40.4	+41 : 41

Appendix 11: Operator's Exam

Before you can officially become a telescope operator and bring people up to the observatory, you msut pass an operator's exam. During the exam, you will be asked to set up the 0.4-m for observing and shut it down again. You will also have to solve a couple of the following problems:

1. What to do if the power goes out while you have a class in the dome.
2. The dome won't rotate. Diagnose why and what to do.
3. The dome upper shutter won't close. Diagnose why and what to do.
4. The dome lower shutter won't close. Diagnose why and what to do.
5. The telescope isn't tracking. Diagnose why and what to do.
6. The telescope won't slew to the next object: diagnose why it won't move and how to fix it.
7. The telescope ran into the software limits. How do you get it out?
8. The telescope ran into the hardware limits. How do you get it out?
9. The PC won't send coordinates to the tcs. How do you operate the telescope?
10. There is nothing visible in the eyepiece. What do you do?

In addition, (and depending on what you do in the observatory) you may be asked to set up a C8 for nighttime or solar observing and put it away again, or set up and take an image with the CCD camera.

Reporting Trouble

There are 3 ways to report trouble:

Use the online Angell Hall Observatory Trouble Report Form at http://www.astro.lsa.umich.edu/obs/angell/ (this should be the homepage for all browsers on the control room PC). You will only have access to this form if your computer is in the university domain (so you might not be able to report a problem from home)

Send email to astro-labs@umich.edu (your must use your uniqname@umich.edu email to use this system)

Call one of the numbers on the phone list on the bulletin board in the control room. Home numbers are listed for emergencies (e.g. the telescope has stopped responding and you can't figure out why)

You should not leave until you have spoken to somebody if:

You cannot get the dome closed

You cannot get the telescope upright

You had to call 911 (unless you have to evacuate the building, accompany someone to the hospital, etc. Please contact someone ASAP though. We don't want to find out about an accident from the evening news!)