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NICKEL TELESCOPE USER'S MANUAL

R.P.S. Stone

Santa Cruz, California
May 1984

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It is intended that this book be used
in conjunction with one for the instrument
you intend to use.

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Many shall run to and fro, and knowledge shall be increased.
Daniel XII, 4

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I. Introduction and General Remarks

The 1-meter Anna L. Nickel Telescope was placed into operation in 1979. It is housed in the dome at the north end of the Main Building, which was formerly occupied by Lick Observatory's first permanent telescope, an Alvin Clark 12-inch refractor. The Nickel telescope was designed and built by Lick personnel, drawing heavily on accumulated spare materials (hence its informal name, the "Spare-parts Telescope"). It is quite remarkable that the telescope was placed into service with a working ITS system for a cash outlay of only about $28,000. For comparison, it's estimated that a commercial 1-meter telescope with dome at this site at the same time, without instrumentation, would have cost about $750,000! Thus, the telescope is a tribute not only to the generosity of Anna L. Nickel, but also to the very clever engineering staff at Lick Observatory.

This manual describes the operation of the telescope. Considerable emphasis is placed on safe operation of the remote television acquisition and guidance system.

The 40 inch is a highly automated telescope, and it is suggested that this manual be read rather completely, since the description of the full operation of a system may fall into more than one section.

It is not permitted for observers to bring friends in for night-time sight seeing. Even daytime visits to Lick telescopes must generally be approved in advance by the Director or the Mountain Superintendent, **and** by the observer scheduled to use the telescope you wish to visit. The reasons for this long-standing policy are 1) that observers should be serious about observing and make the most of observing time granted and 2) in order to avoid the abuse of the telescopes and equipment by casual and perhaps inadequately supervised visitors. Once an observer has carefully set up the equipment, that person should be able to feel confident that nothing will be changed without permission. Consider how you would feel if you set up, and then someone's friend casually twiddled a knob so you observed for one or more nights with a setup different from that which you had made!

Also, observers **may not** check out new observers. To insure that our telescopes and equipment will be used correctly, new observers **must** be checked out by the appropriate Lick staff member. All it takes is to indicate the need on your time request. Once you've all been checked out, then you may of course work out variations of the normal observing procedure with your colleagues.

If you have not observed with the 40 inch for some time and feel uncertain about using it safely and effectively, you are urged to request refresher instruction in your time request. It's best for everyone concerned to be conservative on this. If

you are going to be checked out, a day or two before your run please call the person who will conduct the checkout, in order to arrange a time and place to meet.

For any run, try to arrive early (perhaps for lunch) on the first day in order to check out the equipment, especially if you are the first observer after an instrument change. This will leave some time to correct any problems while the daytime maintenance crew is still around, thereby helping to reduce unnecessary overtime as well as increasing your chances of getting started on time.

The Nickel telescope is scheduled on a quarterly basis, similarly to the 120 inch. This is because many observing projects are long-term dissertation programs, and quarterly scheduling enables better control of the number of users.

Access to the 40 inch and its control room is through the Main Building, which is open to the public. For this reason, it's particularly important to be security conscious. If the building is open, keep the yellow rope across the bottom of the stairs to discourage visitors from wandering up. When you're actually on hand working, it's convenient to keep the dome and control room doors unlocked, but when you leave **please** be sure to lock them again. Also, when the building is **not** open to the public, keep all outside doors carefully locked. There is too much irreplaceable equipment in the building to have people wandering through unsupervised.

The local phone extension (37) can be direct-dialed from other UC campus phones. From off-campus phones the best number to use is (408) 274-1400. By custom, this line is generally answered by the person expecting a call on it. The other outside line (408) 274-5062 may be used, but this busy number is the official outside line and is routinely answered by others and is therefore usually ignored by the 40-inch observer.

II. Dome

Observing is done remotely at the 40 inch. That is, observations are conducted from the control room, so the observer is only on the dome floor during instrument setup periods. For this reason, the dome must be positioned automatically to the position angle dictated by the telescope pointing. The dome slit has been enlarged beyond the original two feet or so used for the 12-inch refractor, as you can see by the new laminated bridge on the left side of the slit; but even the new slit is not overly generous for the 40 inch, allowing only a few inches clearance on each side when the telescope is centered. Dome pointing is achieved by the telescope controller (Sec. IV). There is a track around the bottom inside diameter of the dome, and a wheel is mounted on an arm extending from the north pier of the telescope so that it turns against this track as the dome and the track move past it.

An infrared light/sensor combination counts reflections from radial reflective marks on the wheel in order to determine the position angle of the dome. The zero point is provided by a bump on the track, which is sensed by a switch mounted on the same arm as the wheel. Initialization of the dome is automatic, as is subsequent operation, and requires only that the "auto dome" switch on the telescope controller be turned on.

There are a couple of points to be aware of in actual operation. First, the zero point may not correspond to the optical axis. This can be adjusted by software from the PET telescope control computer (Sec. IV). Second, the top of the dome slit occults the telescope when the telescope is pointed within 4° of the zenith. A red warning light is lit on the controller when this occurs. Of course, this only matters if photometric results are desired. The maximum occultation is about 40%.

The dome may be rotated manually by a two-button paddle on the east side of the south pier. This paddle overrides the telescope controller so long as a button is being depressed, but if auto dome is on, the controller will attempt to reposition the telescope as soon as the manual paddle buttons are released.

The dome is stowed with the slit facing roughly northeast. There is a large black arrow on the gray junction box which moves with the dome, which should be lined up with the arrow on the wall of the dome to the right of the north pier. The reason for having a preferred position angle for stowing the dome is that this seems to be where the dome leaks least during bad storms.

There are three switches on the gray dome junction box which you need to know about. The shutter switch is a white rocker switch which activates a garage door opener mounted on the shutter. Press the spring-loaded switch and **let go** - if you hold it down the shutter will reverse direction at the end of travel. Normally, movement is ended automatically when limit switches are encountered. Once the dome is open, **you are responsible for protecting the telescope** from any weather threat which may arise.

There is a single dim light operated by a switch near the door, but the best dome lighting is controlled by a toggle on the gray dome junction box. This lights up four lights mounted every 90° around the circumference of the dome.

At present, the windscreen is controlled by a three-position toggle switch on the gray dome junction box. Strangely enough, up moves the windscreen up, down moves it down, and the center position is off. Since one is not normally on the floor while observing, this is not a very useful arrangement. Eventually the windscreen will be computer-controlled. For the present, use it if you can while observing, but in any case stow it all the way up. This helps protect the telescope

from leaks.

Notice that the last three switches are mounted on the junction box which **moves with the dome,** so their relative position with respect to the dome floor may vary.

The dome must be closed when any of the following limits are reached:

a) Humidity 95%, or as necessary to exclude moisture from the dome. As you probably know, it's generally nice to let the telescope (and especially the mirror) reach approximately ambient temperature in order to minimize focus changes. This is especially important for CCD direct imaging. Therefore you may wish to open the dome an hour or so before sunset, remove the plastic over, open the mirror cover, and expose the mirror to the sky. If you do so, be very certain to be alert for any sudden weather changes. In particular, fog can form very suddenly over Mount Hamilton, so be alert to this possibility at **any** season. The humidity gauge is in the right-most window opposite the door of the control room.

b) Wind: close the dome whenever the wind velocity exceeds 50 mph. The gauge is on the wall of the control room opposite the door. This limit requires reasonable interpretation. If the wind is steady at 50 mph or above, of course close. But what if it is generally 40, gusting **occasionally** to 50 or 55? Then keep going if you wish, but watch it closely. If it is generally 40, but gusting frequently to 60 or 70, then close up. But as you can see, all possible variations can't be covered, so the ultimate rule is close at 50 and interpret that in a reasonable and prudent way.

III. Telescope

The telescope has an f/5.3 primary mirror of 38 1/2" diameter, and a secondary providing an f/17 Cassegrain focus with an approximate scale of 12.25 arcsec/mm. About 12% of the light is blocked by the secondary. Whenever the telescope is stowed, the R.A. motion is locked by the "R.A. locking bar." This is a long aluminum pole (actually a spinnaker pole from a sailboat) which goes from a tab on the southeast corner of the yoke of the telescope to a fastening point under the floor, via an access panel. If you walk straight ahead when you first enter the dome, you will probably break your toe on it. The purpose of the bar is to keep the telescope from exceeding its limits in case of a power failure. It is usually convenient to remove the bar when you come in to set up. To do so, pull the T-handled pin at the yoke end, move the bar away from the yoke tab and immediately replace the pin in the bar so it doesn't get lost. Then reach down below the floor level and pull the spring-loaded locking pin in the bar upwards along the pole, and move the bar off the fastening point. Meanwhile, be careful not to let the upper end of the locking bar bang into anything. Cover the hole in the floor with the floor panel,

and stow the locking bar on the floor along the wall, out of the way.

The mirror cover is opened and closed pneumatically. The control for this is a black-knobbed lever on the top inside surface of the yoke above the south polar axle. Pull the handle down to open the mirror covers. Movement of the cover may not begin until 5 seconds or so after the handle is moved.

The tub of the telescope (that is, the bottommost round section, of slightly smaller diameter than those above it) can be rotated, for example to place your instrument at different position angles. At the present time, only the ITS spectrograph is balanced for rotation. Any other instrument must be specially balanced by the dome crew before it is rotated. To achieve this, there are three gold anodized locking handles at 120° intervals around the tub where it is attached to the telescope. Turn the handles counter clockwise (looking **up**) to unlock, turn the tub by hand, and relock. This should be done with the telescope pointed to the zenith. The tub is a bit stiff to turn - a smaller person may need help. Turn it slowly and carefully and be careful not to snag and pull out cables as you turn it.

Before any of the paddles or the tracking will work, power to the telescope must be enabled by pressing the telescope power "reset" button. This is one of two buttons on the south side of the large junction box which is mounted on the east side of the south pier of the telescope. It is easy to find - all the telescope paddles hang on the front of this junction box. Just press the reset button and you'll hear a "thunk" as some relays are activated in the junction box. At the end of the night be sure to press the "panic" button next to the reset button to disable telescope power (useful in case you forget to turn off the drive)!

There are four paddles hanging on the junction box. One is the dome rotation paddle, already discussed above. It is the only one with two buttons (left and right) on it. Another paddle has a potentiometer and a black switch sticking out of the top. That is the focus paddle, and it is not normally hooked up except for visual observing during the summer visitors program and for some private use instruments. (Focus is normally done from the control room, and is discussed in Section IV, below.)

So now we're down to the two paddles used to move the telescope during set up (again, telescope motions are normally made remotely, from the control room). The paddle with four red buttons on an aluminum face is the slew paddle. The directions are marked on the side of the paddle, but usually it is sufficient to just press a button and see if it does what you want. The blue anodized paddle with the joystick is the guide/set paddle. It has three slide switches on it. the "dis/ena" switch should always be left in the ena(ble) position on this dome paddle. This switch has to do with computer control of the telescope and will be discussed in greater detail later. The "set/norm" switch is used to choose set or guide ("norm")

speeds. The last switch, labelled "R.A. norm/rev" is used to reverse the sense of the joystick in R.A., if desired. There is aural feedback from the paddle (one click/stepping motor step at slow speeds). If there is any motion left when the joystick is neutralized, press "restart" on the telescope controller (see Section IV below).

The telescope is completely covered with a plastic sheet when it is stowed during winter months. The telescope maintenance supervisor will decide when the plastic covering season begins and ends; so the rule is, if the sheet is in the dome, use it. There are two long wooden handles with hooks attached to the sheet. These hooks are simply hooked onto metal eyes on the east and west outer rim of the secondary ring of the telescope. This is done with the telescope all the way at the south limit. When you take it off you can just let it fall on the floor at the south pier, but please don't walk on it. After you put it back on again, run the telescope well past the zenith to the north, straightening the sheet as necessary so it doesn't catch and tear, and so it covers all of the electronics in racks on the east yoke and the dec drive unit on the west yoke.

There are two finder scopes on the south side of the telescope. They are used just to initially reset the coordinates of the telescope. This is usually necessary if the power to the telescope controller has been shut off, and that in turn generally happens just as a result of a general power shutdown on the mountain (not uncommon during winter storms). The field of the smaller 2 inch finder is in excess of 4°, while that of the 3 inch finder is about 44 arcmins. The 3 inch finder has a grid reticle, and each square of the grid is about 2-3/4 arcmin on a side. Normally one uses only the 3 inch scope. The procedure is to put a star on the crosshairs and reset the dials. This should be good enough so that you can find an Ephemeris star with the TV and touch up the dials. Please do **not** reset the finder scopes. The finder scopes have illuminated reticles whose intensity is controlled by a pot mounted on the telescope a foot or so to the left. Remember to turn the reticles off when not in use.

There are two lights mounted on the secondary ring which may be used for continuum calibrations. Either the white windscreen or a white patch painted on the inside of the shutter may be used as a flat white surface to illuminate. The switch for the lights allows selection of one or both, and it is on a clearly marked 19 inch rack mounted on the east arm of the yoke.

As has been mentioned, the instrument tub can be rotated, so positions of items in or on the tub will be described with respect to the white TV camera case, the back of which protrudes from the side of the tub.

It is necessary for the TV to be able to view both the telescope field and (in some cases) an instrument focal plane, for example spectrograph slit jaws. To

view the telescope field for object identification and centering, a diagonal mirror is inserted (pneumatically, from the control room) into the telescope beam. The light from the telescope secondary is deflected by the diagonal, onto a pair of "folding" (they fold the beam) flat mirrors, and then into the TV.

The diagonal mirror can be moved out of the telescope beam so that light from the telescope passes on down to the instrumental focus. For the ITS, the aluminized apertures are tilted a few degrees, so that light reflected from the slit jaws may pass through a periscope which relays the light, via the folding flats, to the TV for guiding. For some other instruments (e.g., the CCD camera) the solid diagonal mirror is replaced by one with a central hole. Then the object is located on the mirror surface surrounding the hole, and the telescope is translated to move the object into the hole of this diagonal, and thence to the detector. Guiding is then accomplished on the diagonal surface surrounding the hole. The TV is permanently fixed in the tub, so it may not be offset with respect to the detector.

A foot or so to the right of the TV camera on the outside of the tub you'll find a small black box mounted, which contains the emission lamps for wavelength calibrations. It contains three individually selectable lamps; neon, mercury, and a mercury-cadmium combination. The switches are on the box and the lamps **cannot** be turned on and off from the control room. To use the lamps, the diagonal mirror must be in the in position. Then the lamp lights bounce off of a white card mounted on the back of the diagonal mirror, down to the detector.

The two folding flats can be moved together on a screw, to accommodate various focal distances corresponding to different instrumental focal planes. The folding flat mirrors will usually be set up for the correct focal distance by the telescope maintenance crew. If you need to move them, you can get access to the inside of the tub by a small black hatch opposite the TV. Just inside the hatch you'll see a red button in the middle of a black handle between the folding flats. If you push the red button it releases the flats from the screw on which they move so you can slide the mirrors rapidly along their track to a new position. For fine adjustments, the screw is turned by a thumbwheel at the end of the screw inside the tub just above the door.

There is a scale for the flat mirrors mounted inside the tub on the roof. In order to see it, you'll probably have to take off one of the three black cover plates on the bottom of the tub. The one to take off is the one to your left as you face the access door for the folding flats. If you have occasion to take off more than one of the three bottom access plates, notice that they are **not** interchangeable. Each one is stamped with a number, and a corresponding number is stamped on the lower rim of the tub.

If you have an experimental instrument package or wish to hang any ad-

ditional equipment on the telescope, please coordinate closely with the telescope maintenance personnel (ext 51 or 53) regarding telescope balance.

IV. Control Room

In this section I'll discuss equipment that is **not** specific to a particular instrument. Discussion of the TV system is deferred to the next section.

The heart of the telescope is the black-paneled Telescope Controller ("Telco"). Since the controller is busily keeping various clocks up to date, it is normally *never turned off*. There are two switches at the bottom center of the panel. The auto slew switch is not enabled at time of writing. Auto dome is turned on at the beginning of observing, off at the end of the night; the same is true of the telescope tracking switch on the right hand edge of the panel.

There are lots of pretty lights on Telco, and you can usually ignore most of them. Pay attention to the red ones, though. The zenith warning will remind you when the telescope is being partially occulted near the zenith. The limit lights indicate which limit has been reached, so you know which way to drive the telescope to get off the limit.

The track deviation thumbwheels are used to trim the telescope track rate. A typical value within 30° or 40° of the zenith is -0.04. This may vary a bit, and will vary more at larger zenith distances. Increasing the number increases the rate; i.e., drives the telescope faster to the west. The dec rate is set with the other thumbwheels; a plus rate drives the telescope north, and a typical value is zero. The tracking switch only turns off the R. A. drive, so if you have entered a non-zero dec rate, you **must** remove it at the end of the night, or it will just keep going all day.

The display select thumbwheel in the upper right corner is used to select what data is sent from the controller to the telescope controller display monitor. This Telco monitor is in the rack below the controller, and normally only needs to be turned on (toggle switch inside door on front of monitor, at bottom). If display select on the controller is set to 8, information displayed on the monitor will be for the current position of the telescope. If display select is 9, then information for the next object will be displayed on the monitor. Position 13 will present autoguider information when that is implemented, and position 15 automatically switches between "next object" and "current object."

Information displayed on the Telco monitor includes coordinates, hour angle, zenith distance, telescope azimuth, dome azimuth, PST, UT, ST and airmass.

How does the controller know what the next object will be? If it knows that, you don't even have to go up to observe, right? Well, no; you have to tell

it (so far). That's done via a PET computer, which is used to communicate in essential ways with the telescope controller. To start the PET, first turn on the wall-type power switch just above it to the left. This energizes the computer and its disk drive. Load the 5-1/4 inch telescope control system disk (kept in the front of a large black loose-leaf binder), close the disk drive door, and type "shift-run" on the PET. The system will automatically load and run the program. When it is ready ($\approx$ 20 seconds), a menu will be displayed on the PET.

The options from the menus are pretty well documented by help commands, so here I'll just describe them briefly. All of the routines are pretty simple. Prompts are provided, in addition to a help command for each menu.

When the PET is first loaded up, it presents the Main Menu, with options

H Help
1 Initial Setup
2 Telco Operation Menu

Type 1 for the Initial Setup Menu which offers:

H Help
1 Set time and Date
2 Initialize Slit Changer
3 Initialize Star List
4 Return to Main Menu

1 - Set time and date. Initialize the clocks, necessary for proper precession and pointing. Check controller for correct time and date at beginning of night and reset if necessary. Normally only necessary if power to controller has been interrupted.

2 - Initialize Slit Changer. Lets you set up computer controlled moves between any two positions. Originally intended for moving between the two apertures of the ITS, but generally useful. **Not** good for **very** long moves because of slow speed of move.

3 - Initialize Star List. Erases previous user's star list.

4 - Return to Main Menu. If this is confusing, maybe you'd like to be a politician instead.

Typing 2 on the Main Menu will whisk you smartly into the Telco (Telescope Controller, remember?) Operating Menu:

H - Help

1 - Set Telescope (Precession)

2 or > - Slit Change to Right

3 or < - Slit Change to Left

4 - Offset Telescope

5 - Mark Position

6 - Change Tracking Rates (zero autoguider)

7 - Star List

8 - Return to Main Menu

1 - Set Telescope. This doesn't (yet) set the telescope, nor does it (only) precess. Use this to enter coordinates for your next object (any epoch), and Telco will precess to the current epoch, plus correct for flexure, aberration, mutation, refraction, and the Cost of Living Index. It will display the result as coordinates for "next object" (display select 9 on Telco), along with air mass, zenith distance, etc. These are the coordinates one uses for actually setting the telescope, so usually one leaves the Telco display on "next object" while observing.

2 and 3 - Slit Change to Right (Left). These execute the moves set up by Initialize Slit Changer. It is nice to use > for a move to the right and < for a move to the left.

4 - Offset Telescope. This is used to execute offsets. It is a cousin of the slit changer routine. Input R. A. and dec offsets in arcsecs.

5 - Mark Position. You can set the telescope and ask Telco to remember it as Position 1, reset the telescope and tell Telco it is now at position 2, then later move repeatedly between 1 and 2 or vice versa, until you exit the routine. The positions may be separated by very long distances on the sky ($\approx 5 \times 10^5$ arcsec!) but it will only move between them at 45 arcsec/sec. This is useful, for example, for moving between object and sky positions.

6 - Zero Autoguider Rates. Occasionally the autoguider (not available at time of writing, but expected soon) will generate nutty track rates; this allows you to get rid of them gracefully.

7 - Star List. With a menu of its own (including help), this routine allows you to enter a list of up to 100 objects (the program won't reject non-stellar objects), with their coordinates for any epoch. The information is written onto the PET floppy disk. During the night, you may then automatically enter an object into Telco by simply typing its serial number in the list. Telco will precess and otherwise correct the coordinates, and present the results on the next object display. (Eventually Telco will slew the telescope for you, but not yet.) This is a handy option if you'll be repeating observations of a number of objects.

8 - Offset dome. This allows you to adjust the zero point of the dome

rotation so as to center the dome slit carefully on the telescope. Once entered, it will be applied thereafter. It is a good idea to check the centering at the beginning of the night.

Just above the telescope controller is a rack panel which contains the four white telescope slew buttons. Directions are labelled. Let the telescope come to a complete stop before moving in an opposite direction.

On the right-hand side of the same panel are the telescope focus controls, with a digital readout of the secondary mirror position in arbitrary units. The knob functions as a rate control (usually use it all the way up, e.g., clockwise), and the spring-loaded toggle switch actuates the motor.

This same slew/focus panel contains another very important button in the lower right corner, to whit, the red panic button. This button would be useful in case of a telescope malfunction, e.g., a sticking slew button. Keep it in mind.

Above the slew buttons is the digital telescope position display. Hour angle, R.A. and dec are shown. The displayed positions may be reset with the remaining switches. The pointer is confusingly labelled "Hrs, mins, sec, trim" but think of it as a rate selector; "hrs" is fast, "trim" is slow. The toggle selects the direction of change, and the black buttons actually cause the readouts to change as selected. Due to the limited precision of the dec encoder, the minimum dec readout change is two arcsecs. Normally one sets to a bright star with Ephemeris coordinates at the beginning of the night, centers it on the detector, then resets the readouts to the Ephemeris position.

The digital sidereal time clock just above the telescope position display seems to be very sensitive to power fluctuations and therefore may need resetting. The three buttons are fast advance, slow advance, and hold. Alternatively, ignore it and get S.T. from the telescope controller display.

One difficulty with Telco is that it is sensitive to voltage fluctuations, and the same is true of the digital position displays. Particularly during the winter, line voltage fluctuations are not uncommon. This causes two levels of problems. If the voltage is off for more than 5 or 10 seconds, when it comes back on then Telco experiences a complete restart, and internally everything should be reset properly. In this case it often comes back up with crazy telescope coordinates, and if they're crazy enough, Telco will shut down, and sound a shrill warning buzzer. All that is necessary is to reset the telescope coordinates to the values suggested by Telco on the Telco monitor, and Telco will then recover (slew will be disabled until the coordinates are reset). Then set time and date, and touch up the coordinates and all should be well.

The second case may be a bit trickier at first to figure out. If the voltage

fluctuation is more of the brown-out variety, Telco may not shut down and therefore it may not execute a restart when the voltage returns to normal. In this case, Telco may become quite psychotic and, like other sentient creatures, may deny it has a problem, even though portions of its internal logic may be quite scrambled. In this case, if it won't look you in the eye or won't let you back in the airlock, try pressing the red "restart" button on Telco. If that doesn't work, then turn the Telco power off for 15 seconds or so and start it up from scratch. This is probably the only circumstance in which you should ever turn off Telco.

Telco may display various useful error messages to you. For example, if it knows it doesn't know the correct time and date (this is usually monitored inside by a gnome with a Rolex watch * and a desk calendar) it will ask for it; if the hour angle and right ascension are inconsistent, it will require you to reset them (and also suggest what to set them to - usually one sets R.A. from a star and then corrects the hour angle as necessary); and it will inform you if the dome encoder appears to be slipping. If the R.A. and H.A. are inconsistent, notice that Telco will display the current position of the telescope, even if you have selected next object.

Finally, another error message may appear behind the red lucite panel at the very bottom of the rack which contains Telco. That message is "no air pressure." Air pressure is required for operating the clutches of the telescope drive, as well as for operation of the mirror covers and the diagonal mirror. The proper response to this message is to call maintenance.

V. TV Acquisition and Guiding

So now, with fear and trembling, we get to the TV. "So what's the big deal? I grew up with TV," you assert. Yes, but this isn't just another 13 inch portable. This is a venerable old Westinghouse SEC Vidicon camera, which has somehow miraculously survived 15 years of use at telescopes. Its target has probably had more celestial objects on it than any other in the world. But none of that is really the point. The point is, the image tube in front of the camera is a very old style, which we believe cannot be replaced. There is no spare on the mountain, there is no spare in Santa Cruz, there is no spare **anywhere.** In addition to that, it is rather vulnerable. As you will appreciate by now, without the TV we can't use the telescope. So, **please** read this section carefully, with special attention to the usage procedures at the end.

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* I am indebted to R. Kibrick for pointing out to me that the Rolex watch plan was abandoned out of economic necessity. In fact, a cheapo Timex with no calendar feature (hence the desk calendar) is used. If a Rolex was available, we would not need to feed in time corrections, would we?

I first mention the switch which is least obvious and which you are therefore most likely to forget. At the top of the rack with Telco is a CAMAC crate which must be on (toggle switch on far right of crate) to get video to the monitor. The reason is that the crate powers a cross generator (in left side of crate) through which the video signal passes, in order to superimpose three +'s on the video field which may be moved around as reference marks. The cross generator has a pair of knobs for moving each + up and down, left and right. A single knob at the bottom of the cross generator varies the brightness of all three crosses. I emphasize again that if you're not getting a TV image at all when you think you should be, make certain the rate meter crate power is on.

All other TV controls are in the rack between the Telco rack and the PET computer rack. There are five items in this rack, four of which have separate power switches, but do **not** turn on the camera control power until the last minute. Do turn on the power to the narrow Telemation sync generator at the bottom; do turn on the power to the black "video frame buffer" - not a very catchy name, is it, so let's use "TV memory" instead - ; and do open the small door on the Conrac TV monitor and turn on the power to it with a toggle switch inside the door. The other knobs inside the door on the monitor are the usual ones for adjusting TV's, such as brightness, horizontal hold, etc; you probably won't need them. A small toggle switch just outside and below the door inverts the display. Usually if this switch is in the up position, north will be at the top on the monitor, but of course this depends on the position angle of the tub.

The reason for skipping over the power switch on the Camera Control is that it applies power to the camera tube itself. Before doing that, one wants to be certain that everything else is properly set up, so camera power is about the last thing to turn on.

Looking again at the TV memory (video frame buffer) the polarity switch in the upper left corner allows you to choose negative polarity (e.g., sky survey format, black stars on a light background), or positive polarity (real world format). The next switch to the right chooses the output to the monitor either directly from the camera (thus bypassing the TV memory) or from the memory. When the camera is first turned on, this switch should **always** be in the camera position, so the camera will be read out immediately and continuously. The pot next to it labelled "integration time" controls the length of time an image is allowed to accumulate on the target of the camera tube before being read out to the TV memory. The toggle switch in the upper right hand corner, labelled "store" and "inhibit" is nearly always left in the "store" position, so that when integrating, an image read from the camera will be read to and displayed from memory. The alternative (inhibit) will not store the image, so when it is read out directly to the monitor at the end of

the integration cycle, it will just flash it quickly on the screen - not usually a useful mode. Finally, there are two pots in the lower left marked "size" and "position." These are for adjusting the gray scale of the TV memory, so you can (in theory) control the contrast displayed. The "size" varies the range in brightness which is displayed, and "position" varies the zero point so (in theory) you can adjust it for a narrow dynamic range centered on either bright or faint objects; or you can adjust it for a wide dynamic range with relatively coarse steps. It sounds great, but you may have noticed a tinge of skepticism. I find these controls very difficult to set up in a useful way. I usually just try to find something that works, and then leave them. I hope you have better luck.

The TV control is the black panel just below the TV memory. On the right is the diagonal mirror control. This, you will recall, refers to the diagonal mirror inside the telescope tub. The switch moves it between in (in the beam, full field to TV) or out (diagonal mirror out of the beam). A sliding panel may be moved in front of the switch. Normally it is out of the way and out of view, but when it covers the switch one sees the warning "Please do not move diagonal mirror." It is possible to have things mounted inside the tub which interfere with movement of the mirror. If the sliding door is covering the switch, it probably means what it says. If you don't expect that, or if you need to move the mirror, the best thing to do is to check with telescope maintenance at extension 51 or 53. Observers should never open or close the sliding door; it is for use by the maintenance crew only.

On the left-hand side of the TV control are the shutter, gain and interlock reset controls. The shutter control is probably the single most important switch of all with respect to the TV. That is why it is red. In case of a TV emergency, **close the shutter** . The shutter control acts nearly instantaneously, whereas the gain control, for example, is slower, so to close the shutter is the fastest TV protection. The gain control is straightforward. Always turn it up **slowly** so as not to burn the camera with an unanticipated bright object.

The rule is to **always** turn off the TV camera control (e.g., the high voltage to the camera tube) before going onto the dome floor. As a backup, there is an interlock on the door onto the dome floor which will close the shutter in case anyone should open that door, but do not depend on the interlock. It is only a backup and is not a substitute for turning **off** the TV. Still, anytime the door has been opened, it will be necessary to reset the interlock by pressing the interlock button on the TV control, before the shutter will open manually again.

Now at last we come to the camera control. Before turning on the camera, be sure the lights are off and it is dark in the dome, no comparison lamps are on in the tub, the door to the dome floor is closed; on the TV memory, the integration time is set to minimum, and output is set to camera; on the TV control the gain is

at minimum, the shutter is closed, the interlock is reset and diagonal mirror is set as desired. That seems like a lot to check, but after a couple of times it will make sense and seem less forbidding. Open the door on the camera control and find the "G5 short" button mounted on the end of one of the printed circuit boards. Press the G5 short button, turn on the power to the camera with the rocker switch to the left of the door, and **continue to hold** the G5 short button down for 15 seconds - this will prevent any large current surges from harming the camera as it warms up. If all is well at this point, the monitor should look a bit "speckly" from camera noise. Then open the shutter, and turn up the gain slowly.

In order to look at very faint objects, turn the camera gain all the way down, check the "store/inhibit" switch on store, and integration time to minimum. Select "memory" with the output switch, turn the gain up to or near max, and only then, very slowly and carefully, increase the integration time. I strongly recommend that you use gain rather than integration to see faint things. Picture quality is best without integration, and if you must integrate, keep the gain up so the integration time is as short as possible. While the camera is integrating, it is vulnerable. In particular, be very careful about moving the telescope around while integrating. Make only very small motions (as in guiding or final set up) and be very certain not to accidentally move onto a bright star while integrating.

A couple of useful guidelines for judging when an object is too bright for the TV are 1) when you move the telescope, objects should **not** leave trails on the TV, and 2) if a bright in-focus star turns black in the middle, that's **dangerously** too bright and a catastrophic failure is imminent.

Here is a summary of things to be cautious about when using the TV:

1) **Always** turn off the camera control (i.e., camera high voltage) when going onto the dome floor.

2) **Always** turn the integration to zero, turn off the integration switch, turn the gain to zero, and close the shutter before moving to a new object. And relatedly,

3) **Always** check the gain at zero and the integration switch off and integration time at minimum before opening the shutter at a new field. **Then** open the shutter and turn the gain up cautiously. Always assume that, even though you know the brightest object in your field is 21st magnitude, this may be the time the moon is in the middle of it, or the telescope malfunctioned and you're centered on Sirius. Even if you think you've just set back from a nearby position, please follow this conservative procedure. It doesn't take long.

4) When searching for your object, be alert for an unexpected bright star coming into the field. Train yourself to **close the shutter**,which responds instan-

taneously, rather than turning down the gain which entails some delay. Then follow the procedure above to reopen the shutter.

5) Be cautious about clouds, especially when the moon is up. The TV is especially sensitive to large areas of high surface brightness.

6) Do not let the TV see anything brighter than 5th mag. If something brighter than that is in the field with your object, a neutral density filter must be used. This is discouraged, because at present it is necessary to tape the filter over the shutter, which is just a little tricky. Avoid such bright objects if possible, but if you need to do it, ask Rem to show you how to install the N.D. filter.

7) Since we cannot move the TV with respect to the detector, it may happen that a bright star is in the TV field with your faint object, so that you cannot turn the TV gain up enough to see your target object directly. If so, you may still be able to find your object by fishing for a signal with your detector and then guiding on the bright star, or you may be able to position your object so that the bright star is out of the field, or you may be out of luck.

8) It has been heartening to see the high level of care which observers to date have exercised. I never thought the TV would survive this long. Don't screw up our good record. Be careful; build these good habits and use them, **please** !

It is useful to know what the TV can do. Unfortunately its performance hasn't been very stable over the last few years. It is old, and every time a problem is fixed, it seems to come back operating a bit differently. So, not to be taken too seriously; 16th mag seems to be fairly easy, 17th is generally achievable, and one careful user a couple of years ago reported seeing $\approx$ 19th on a dark night.

VI. Special Cautions and Summary of Limits

In addition to the telescope limits already discussed, there are a few points of which to be extra careful.

First, before attempting to move the telescope, be especially sure the dome floor is clear. That is, move everything well back against the dome walls. Since most telescope movements are done remotely, they are also done blindly, so it is important that there be nothing it can run into.

Second, I want to emphasize again that the weather can change very quickly, and fog or rain sometimes come up suddenly and occasionally unseasonably. So keep an eye on it.

Finally, in the summer and fall it is not uncommon to have forest fires in the general area. Even if the fire is miles away, the mirror surfaces **must** be carefully protected from any windborne ash from the fire. The reason is that the ash plus

moisture forms acids that can actually **etch the glass** , so please do everything possible to protect the mirrors. Usually in such a case the telescope assistants at the 120 inch will be monitoring the ash closely, so if they ask you to close up you must do so **immediately** , and don't reopen until they tell you its OK. On the other hand, if you suspect ash fallout, please close up immediately and tell the 120 inch - maybe they won't be aware of it yet. Thank you.

Limits Summary

Wind: Steady at, or significant gusts over 50 mph.

Humidity: Close if relative humidity exceeds 95%, or as necessary to exclude moisture. Please note that it takes special effort to keep aware of changes in the weather when you're observing remotely from the control room. Nevertheless, you will be the responsible person if you fail to protect the telescope and equipment from moisture. Be aware of trends in the weather, and look or go outside as often as necessary.

Telescope Position Limits:

Hour angle: 5^h 30^m E or W

Declination: +67° 30′, -39.5°. Slew is disabled and set speed only is available north of + 65°

Elevation: 13°

Zenith: Partial occultation by dome at $< 4°$

TV: 5th magnitude maximum

VII. How to Get Help

If you're not sure what the problem is, please call Rem (ext 40) day or night, and we can very often diagnose and resolve it over the phone.

Mechanical and electronic help is generally available from the 120 inch (ext 51 or 53) during daytime and the first half of the night. Later, try to exercise some judgment about calling for help, considering the importance to your program of the time remaining of the night, the likelihood of a quick fix, cost to the observatory of the overtime, and whether it is really worth getting some poor soul out of bed. It may help to discuss it with the Telescope Assistant at the 3 meter (ext 51 or 53), in order to reach a reasonable decision. If you think the problem can be fixed reasonably quickly, then by all means do call for help, even if it is late.