Acknowledgements & Introduction to

The Historically Corrected New General Catalogue™

of Nebulæ and Clusters of Stars

(HCNGC)

by Robert E Erdmann, Jr.

ACKNOWLEDGEMENTS

The NGC/IC Project gratefully acknowledges the efforts and work of the following groups and organizations for which we could not have accomplished our goals. Our hat is off to each and every one of them.

The Sky Surveys, DSS, and STScI:

The Digitized Sky Surveys were produced at the Space Telescope Science Institute under U.S. Government grant NAG W-2166. The images of these surveys are based on photographic data obtained using the Oschin Schmidt Telescope on Palomar Mountain and the UK Schmidt Telescope at Siding Spring. The plates were processed into the present compressed digital form with the permission of these institutions.

The National Geographic Society - Palomar Observatory Sky Atlas (POSS-I) was made by the California Institute of Technology with grants from the National Geographic Society.

The Second Palomar Observatory Sky Survey (POSS-II) was made by the California Institute of Technology with funds from the National Science Foundation, the National Geographic Society, the Sloan Foundation, the Samuel Oschin Foundation, and the Eastman Kodak Corporation.

The Oschin Schmidt Telescope is operated by the California Institute of Technology and Palomar Observatory.

The UK Schmidt Telescope was operated by the Royal Observatory Edinburgh, with funding from the UK Science and Engineering Research Council (later the UK Particle Physics and Astronomy Research Council), until 1988 June, and thereafter by the Anglo-Australian Observatory. The blue plates of the southern Sky Atlas and its Equatorial Extension (together known as the SERC-J), as well as the Equatorial Red (ER), and the Second Epoch [red] Survey (SES) were all taken with the UK Schmidt.
[Go to http://archive.stsci.edu/dss/index.html]

HEASARC's SkyView:

We acknowledge the use of NASA's SkyView facility
[Go to http://skyview.gsfc.nasa.gov] located at NASA Goddard Space Flight Center.

IPAC's Skyview:

This research has made use of IPAC's Skyview Image Display and Analysis Program, developed with support from the National Aeronautics and Space Administration. [Go to http://www.ipac.caltech.edu/Skyview/].

NED (NASA's Extragalactic Database):

This research has made use of the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration. [Go to http://nedwww.ipac.caltech.edu]

IRSA (2MASS access):

This research has made use of the NASA/IPAC Infrared Science Archive (IRSA) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration. [Go to http://irsa.ipac.caltech.edu].

SIMBAD:

This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France. [Go to http://simbad.u-strasbg.fr/].

LEDA:

We have made use of the LEDA and HyperLEDA databases
[Go to http://leda.univ-lyon1.fr].

ADS:

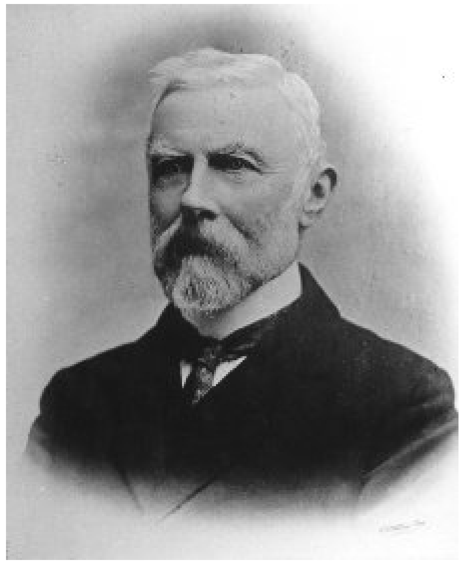
This research has made use of NASA's Astrophysics Data System Bibliographic Services. [Go to http://adsabs.harvard.edu/ and
http://adsabs.harvard.edu/historical.html].

SAO:

This research has made use of SAOImage DS9 (DSS image viewer), developed by Smithsonian Astrophysical Observatory"
[Go to http://hea-www.harvard.edu/RD/ds9/]

Software Bisque:

For supplying The NGC/IC Project with up to date copies of TheSky & CCDSoft to aid in our access of the DSS 102 CD-ROM set. They were of immeasurable value.



John Louis Emil Dreyer
(1852 - 1926)

The New General Catalogue of Nebulæ and Clusters of Stars, which the late John Louis Emil Dreyer published in the Memoirs of the Royal Astronomical Society in 1888, was a monumental work in its day. Even today, it would be considered by most to be a major effort, especially in light of the fact that there was no global satellite communications, computers, Internet, photographic sky surveys, space-based telescopes, or other technological advantages that we take for granted. This in itself is a tribute to Dreyer and his staff, for they compiled and edited a list of 7,840 objects submitted by more than 100 different observers, all discovered and observed visually, whose observing skills spanned the entire spectrum from organized and disciplined to almost certifiably incompetent.

Because of the sheer number of new objects being cataloged, it was impossible to double-check each and every one at the telescope eyepiece. This resulted in an all-sky catalog with almost a thousand known or potential identification problems, but because it was the only one in widespread use for half a century, most all scientific astronomical papers and journals would traditionally refer to an object's NGC designation for identification purposes.

Additionally, if their object of study didn't have an NGC designation, they would arbitrarily assign one based upon the NGC designation of the closest nearby cataloged NGC object. (More on this later). It should also be noted by the reader that the NGC was created during a period of time before the concept of a "galaxy" was known, hence astronomical papers and catalogs of the day referred to them as "nebula" or "nebulæ". It wasn't until 1924, when Edwin Hubble publicly announced Cepheid variable stars in the Andromeda galaxy (NGC 224), and as a result calculated their distances from our Milky Way, that the concept of objects far outside our own Milky Way (extragalactic objects or galaxies) was widely accepted (except for the two Magellanic clouds).[1][2] As a result, the original NGC (published in 1888) doesn't contain the word "galaxy", but only "nebula" or "nebulæ".

It is this quest for "nebulae", by the discoverers of objects that made it into the NGC, which resulted in single, double, and triple stars being cataloged by Dreyer. The discoverers suspected that the single, double, or triple star was surrounded by nebulosity, and hence should be an object of interest to Dreyer. Most of these suspected stars with nebulosity turned out not to have any nebulosity associated with them, as was later born out by photographs taken of the object, but by that time they had been issued an NGC designation by Dreyer and published in the NGC. This has resulted in 114 single stars, 104 double stars, and 36 triple stars being cataloged by Dreyer and issued NGC designations.

Because of this, the NGC is a window into the golden age of 19th century astronomy, and it is tradition, even today, to refer to an object's NGC designation even though it may also have been cataloged in much more recent catalogs, such as UGC, MCG, CGCG, etc. Because of this, it is very important that NGC designations accurately reflect the actual object originally discovered and not something nearby that was never intended as the discovery object, or even seen by the discoverer. This is the driving force behind The NGC/IC Project in our quest to find as many of the "nonexistent" and misidentified objects as possible, and in so doing, ultimately correct the scientific record and accurately reflect the achievements of the original discoverers.

Throughout the history of the NGC there have been many attempts at correcting the errors, but all seemed to fall short of their goal for a number of reasons. Upon study and reflection of these various attempts, it becomes somewhat clear that there are three major factors that led to less than optimal results. The first is lack of time to do the necessary research, the second is failure to use the historical record as a source of data and information, and the third is lack of sufficiently powerful tools to aid in the detective work. For a detailed analysis of these efforts, see "*An Historical Perspective*" (on the Project's web site[3]) by Dr. Harold Corwin, who spent decades collecting photocopies of the original discoverer's published (and sometimes private) notes for the particular objects that made their way into the NGC. These discoverer's notes were used as the foundation and starting point for the Project's research efforts, and have borne an unimaginably rich harvest of information needed to set the record straight. Most of them are part of the *"Historical Record"* portion of the project's web site[3], and can be viewed by clicking the “Historical Record” button on the home page of the Project’s web site[3]. Additionally, the Project has had no time limit or dead line ("We will be finished when we are done and not before"), which all together has resulted in a total count of 82 "Not Found" objects in the HCNGC, in stark contrast to the 793 "Nonexistent" objects in the RNGC, and 618 "Nonexistent" or type "unknown" in the NGC 2000.0. It should also be noted that the Project's efforts took place at a point in time when all of the needed technology and tools came together which previous attempts did not possess. Tools such as The Digitized Sky Surveys I & II (DSS), the Internet, NASA's Extragalactic Database (NED), and many more. These tools, the time to do the research, and the rich historical record, all contributed to our success to date, with work still ongoing to further enhance the accuracy of the original NGC.

The NGC/IC Project started in earnest in 1993, when the father, and champion, of the project, **Dr. Harold G. Corwin Jr.**, assembled a list of interested professional and amateur astronomers whose skills and interests closely matched what he imagined the needs of the project might be. Each of us worked mostly independently with good cross communication and slowly the number of "bugs" (puzzles) in the original NGC started to diminish.

The original core team consisted of **Harold Corwin**, **Brian Skiff**, **Steve Gottlieb**, **Brent Archinal**, **Glen Deen**, **Malcolm Thomson**, **Alister Ling**, **Steve Coe**, and **Bob Erdmann.** Additional members, such as Ron Buta, Dave Riddle, Jenni Kay, Christopher Watson, David J. Frew, and Wayne Johnson were added later on an individual basis. Each team member worked in their chosen area of interest and at their own pace. Over the years, some of the original team members have gone inactive, with the newer team members taking up the slack.

Through it all, Dr. Harold Corwin was, and is, the Project's focus for NGC puzzle solutions**.** (A number of Project team members have collaborated with Harold on solutions to the NGC puzzle objects over the years, and his Historical Notes for the objects contain most of the detail information on these collaborations). Harold also has kept an up-to-date list of accurate positions for each of the objects taken from contemporary scientific literature over the last 3 or 4 decades.

Brian Skiff, of Lowell Observatory, made available all of his data and information regarding NGC/IC planetary nebulae and galactic globular clusters, as well as his UCAS Catalogue of Galaxies. Steve Gottlieb has visually verified most of the original NGC objects (6571 visual observations), as well as working on verifying the Project's proposed corrections with his 17.5-inch telescope. Steve, working with Harold, has been instrumental in solving a number of previously "Not Found" objects. Malcolm Thomson has done extensive research into the Index Catalogs (IC I & II), and supplied numerous in-depth explanations to support the many NGC to IC equivalencies. Brent Archinal contributed his vast information and knowledge about The *"Non-Existent" Star Clusters of the RNGC"*, and advised and consulted with us on many more of the puzzles in the original NGC.

In my case, I acted as a modern day Dreyer, assembling all of the work of most of the project team members into a coherent database of information, as well as generating and annotating DSS images for each of the 7,840 NGC objects; entering the original NGC into the computer by hand; building and web mastering the Project's web site, and doing general paper chase research on some of the known puzzles in the NGC.

The result of all of this is "The Historically Corrected New General Catalogue™ (HCNGC)", which is formatted as an ASCII table (flat file) for easy importing into any number of other applications, or to be used as is. A delimited version, as well as an Excel spreadsheet version, are also available on the Project's web site[3]. It is a mix of both historical information as well as contemporary data about each of the objects.

---

[1] *The History of Astronomy from Herschel to Hertzsprung,* (ISBN 0-521-25733-6) 1973, by Dieter B. Herrmann, Page 149
[2] *Historical Notes for NGC 6822/IC 4895 by Dr. Harold G. Corwin, Jr. available at http://www.ngcic.org/corwin/default.htm*
[3] The NGC/IC Project's web site is located at http://www.ngcic.org

Catalogue Contents

In order to better understand the organization of the HCNGC table, an explanation of the contents of the HCNGC is as follows:

Column Name: NGC No.
Column: 1

Concise Explanation:

This column contains the original NGC designation from the original New General Catalogue.

Full Explanation:

This column contains the original NGC designation from the original New General Catalogue. It runs consecutively from 1 to 7840, the original number of objects in the NGC. There are a number of objects that have appeared in the scientific astronomical literature during the first half of the twentieth century that have an alphabetic suffix attached to the original NGC designation. There are no such objects in the original NGC, nor do they appear in the subsequent Index Catalogs as well, so what are these objects, and where did they originate?

The Short Answer

Between the time that the NGC was published (1888), The Index Catalogues I & II (1895 & 1908), and the avalanche of deep-sky object catalogs (RNGC, CGCG, UGC, MCG, PGC, etc.), which were published starting in the second half of the 20th century as a result of the Palomar Observatory Sky Survey (POSS), there was an annoying lack of object designations for those objects which hadn't made it into the NGC, but which were being discovered, studied, and written about by astronomical researchers of the time. Rather than refer to their object as an anonymous galaxy with a particular RA and a DEC, they assigned, for the purpose of their scientific paper, the same NGC designation to their object as the closest NGC object, but with an alphabetic suffix, such as "A", or "B", or "C" etc.

The Long Answer

Most researchers that arbitrarily assigned an alphabetic suffixed NGC designation to their object of interest assumed that it would be retained by the astronomical community only for the purpose of their research, and would be promptly forgotten thereafter. An example of this is a paper by Philip C. Keenan, of Yerkes Observatory, published in 1936 (*Studies of Extra-Galactic Nebulae, 1936ApJ....82...62K*) , whereby he publishes a list of 32 new galaxies all with alphabetic suffixed NGC designations. He writes at the end of his paper "Temporarily each nebula is designated by the number of the nearest NGC object on the plate, followed by a capital letter." The operative word here is "Temporarily", but some of the temporary alphabetic suffixed designations, assigned by a myriad of astronomers and researchers, "stuck", and are with us today as they found their way into the classic galaxy catalogs, later generated in the mid-twentieth century.

Additionally, other astronomers, such as Holmberg in 1937, publishes a multiple galaxy list assigning alphabetic suffixed NGC designations to faint galaxies surrounding bright NGC galaxies. A good example is his assignment of designations for galaxies surrounding NGC 6166 (located in the Abell 2199 galaxy cluster), which is a Bmag=12.9 galaxy originally discovered by William Herschel (H II-875). The NGC description is "pF, S, vlE, vgmbM", which translates to "pretty faint, small, very little extended, very gradually much brighter in the middle" with no mention of any faint surrounding nebulas. Herschel's own description, from his *Catalogue of 500 New Nebulæ, and Clusters of Stars* published in 1802, is "pB, S, lE, vgmbM" which translates to "pretty bright, small, little extended, very gradually much brighter in the middle". Again, there was no mention of surrounding or associated nebulas.

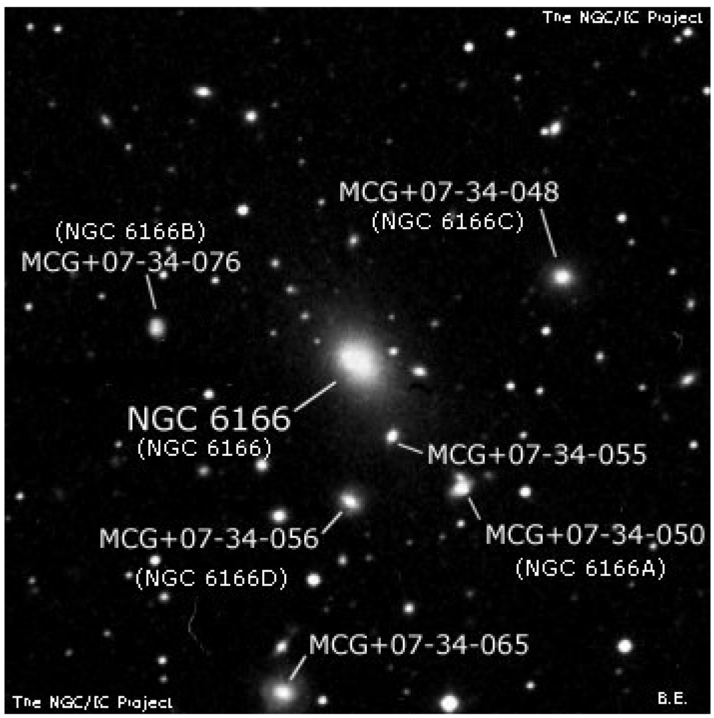


Figure 1

The surrounding galaxies named by Holmberg (NGC 6166A thru NGC 6166D) are all Bmag 15.5 to 16.0, which is 6 to 15 times fainter than the original NGC 6166, which probably explains why Herschel didn't see them. Dr. Harold Corwin sorted them all out privately, but never published them until they first appeared on this web site, seven years ago, as his **Historical Notes**. They are shown in parentheses under or above the MCG designations in the DSS image denoted as Figure 1 above. William Herschel makes no mention of any of them in his notes, and apparently only saw the bigger, brighter NGC 6166 from what we can tell from the historical record.

Another class of arbitrary alphabetic suffixed assignments occurred when it was discovered photographically that what had once been thought to have been a single object (discovered visually), was in fact two or more objects, such as NGC 317, or was originally described as two objects in the NGC, but only a single NGC designation was assigned to them by Dreyer, such as in the case of NGC 3058.

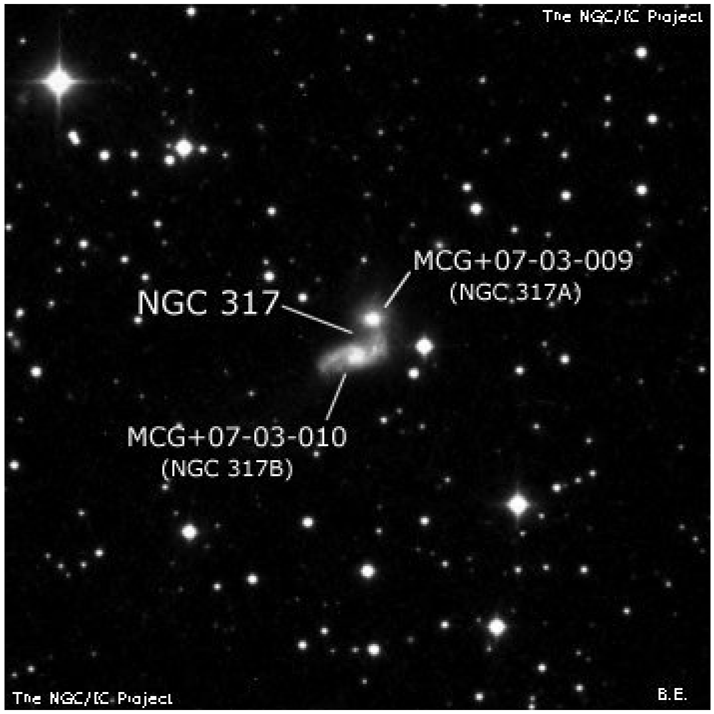


Figure 2

In the case of NGC 317 (see Figure 2 above), Dreyer describes it as "eeF, pS, lE, D * close f", which translated means " most extremely faint, pretty small, little extended, double star following closely" which doesn't give a hint of being a multiple galaxy system, yet today the most northern galaxy is referred to as NGC 317A and the most southern referred to as NGC 317B by modern catalogs. They are shown in parentheses under the MCG designations in the DSS image denoted as Figure 2 above.

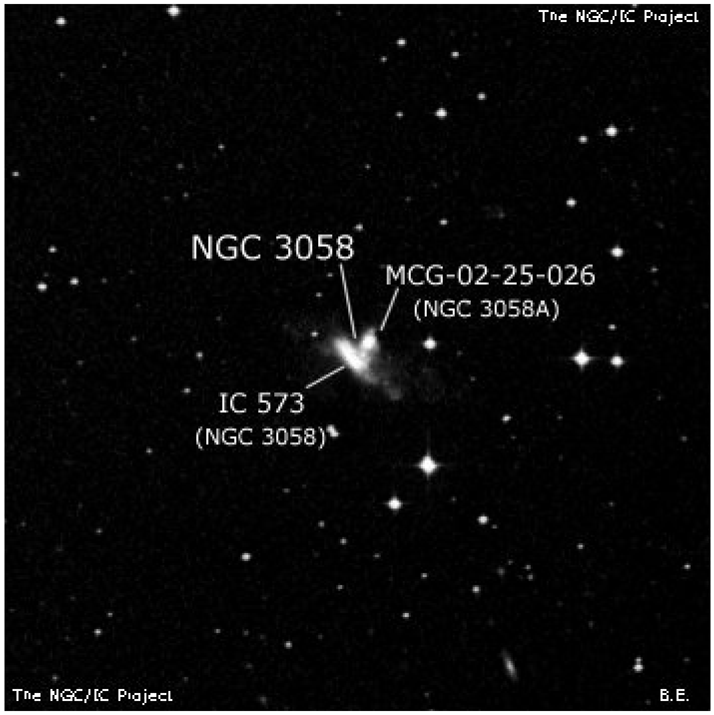


Figure 3

In the case of NGC 3058 (see Figure 3 above), Dreyer describes it as "eF, pL, D or biN", which translates to "extremely faint, pretty large, double or bi-nuclear", so Dreyer actually says that it's a double nebula, but he assigns only one NGC designation (NGC 3058) to encompass them both, with modern catalogs leaving the brighter and larger southern galaxy to keep the NGC 3058 designation, and assigning NGC 3058A to the fainter, smaller more northern galaxy. They are shown in parentheses under the MCG and IC designations in the DSS image denoted as Figure 3 above. An interesting side note on this object is that a later mis-identification in the IC I, assigns IC 573 to the larger, more southern NGC galaxy as well.

Due to the historical nature of the NGC, and the corrections the Project team is constructing, the Project's HCNGC database will not reflect any alphabetic suffixed NGC designations. Later catalogues did indeed catalogue these objects, and gave them their particular catalogue designation i.e. MCG, UGC, CGCG, etc., and they also included the previously assigned alphabetic suffixed NGC designation assigned by one of many early 20th century astronomers, but the damage had been done, and we now drag these alphabetic suffixed objects around with us in more recent catalogs even though they have no historical basis in the NGC, and in most cases, were not even noted by any of the original discoverers of objects that were included in the NGC by J.L.E. Dreyer. The end result is that the alphabetic suffixed NGC objects will not appear in this Historically Corrected New General Catalogue (HCNGC) as they were never a part of the original NGC or the subsequent IC's.

Column Name: L
Column: 6

Concise Explanation:

This column contains the line number (usually 1) for the object designation as shown in the "**NGC No.**" column.

Full Explanation:

This column contains the line number (usually 1) for the object designation as shown in the "**NGC No.**" column. This column is used to indicate whether an additonal line was needed to finish writing the remaining "**Also Cataloged As**" object designations. In most cases there is but one line per NGC object, but occasionally, there were a sufficient number of additional catalog designations for the NGC object that it made more sense to continue them on a second line. When this occurs, a number 2 will appear in this column, with the "**NGC No.**" column left blank, and signifies that there are additional other catalog designations for the object, starting in column 292 of the 2nd line.

Column Name: GC
Column: 8

Concise Explanation:

This column contains the General Catalogue (GC) designation for the object.

Full Explanation:

This column contains the General Catalogue (GC) designation for the object. This is basically the same as is shown in the original NGC, and is included here for historical continuity and consistency. This column is 16 characters wide so as to be able to display the actual contents of what was originally published in the NGC, such as multiple GC equivalencies. e.g. for NGC 586 the GC column shows "343 = 344 = 346"

Column Name: JH
Column: 26

Concise Explanation:

This column contains the John Herschel (JH) designation for the object.

Full Explanation:

This column contains the John Herschel (JH) designation for the object. This is basically the same as is shown in the original NGC, and is included here for historical continuity and consistency. This column is 11 characters wide so as to be able to display the actual contents of what was originally published in the NGC, such as multiple JH equivalencies. e.g. for NGC 3136 the JH column shows "3229 = 3231". John Herschel designations usually start with a lower case "h" followed by a space and then a one to four digit number. They were originally published in John Herschel's Slough Observations (published in 1833), and Cape of Good Hope observations (published in 1847). In the case of this column, the lower case "h" has been omitted, and only the numerical designation is shown. Examples of this would be: h 3456, h 22, etc.

Column Name: WH
Column: 38

Concise Explanation:

This column contains the William Herschel (WH) designation for the object.

Full Explanation:

This column contains the William Herschel (WH) designation for the object. This is basically the same as is shown in the original NGC, and is included here for historical continuity and consistency. This column is 18 characters wide so as to be able to display the actual contents of what was originally published in the NGC, such as multiple H equivalencies. e.g. for NGC 3423 the WH column shows "IV 6 = II 131". William Herschel designations usually start with an upper case "H" followed by a space and then a Roman numeral (indicating one of eight classes of objects per William Herschel's classification system), then a hyphen or dash "-", and then the actual number of the object. Examples of this would be: H III-841, H II-23, H VIII-32, etc.

As a side note, William Herschel's 8 classes of objects are as follows:

Class I - Bright nebulae
Class II - Faint nebulae
Class III - Very faint nebulae
Class IV - Planetary nebulae, stars with burs, remarkable shapes, etc.
Class V - Very large nebulae
Class VI - Very compressed and Bright clusters of stars
Class VII - Pretty much compressed clusters of large or small stars
Class VIII - Coarsely scattered clusters of stars

Column Name: RA(2000)
Column: 59

Concise Explanation:

This column contains the Equinox 2000.0 Right Ascension in hours (h), minutes (m) , and seconds (s), and tenths of a second for the object.

Full Explanation:

This column contains the Equinox 2000.0 Right Ascension in hours (h), minutes (m), and seconds (s), and tenths of a second for the object. The original NGC's Equinox was for 1860.0, and so is not very useful for locating objects today. All of the RA positions in this table are originally derived from B1950.0 positions as published in the **Accurate Positions Files** by Dr. Harold G. Corwin. The B1950.0 Equinox positions were precessed to 2000.0 Equinox using Newcomb's rigorous precession engine algorithm. All positions were then verified (validated) against images generated from the Digitized Sky Survey (DSS-I and DSS-II). As a side note, it should be noted that the difference between Equinox 2000.0 and Julian Equinox 2000.0 (J2000) is only noted in the hundredths of a Right Ascension (RA) second, and tenths of a Declination (DEC) arc second. Both positions yield the same center pixel in a DSS image. Since the Project's positions only go to the nearest tenth of an RA second and the nearest DEC arc second, there is usually no difference between Equinox 2000.0 positions and Julian Equinox 2000.0 positions. The positional accuracy that we chose for the Project is far greater than what is needed to unambiguously identify the object in the sky.

Column Name: DEC(2000)
Column: 75

Concise Explanation:

This column contains the Equinox 2000.0 Declination in degrees (°), arc minutes ('), and arc seconds (") for the object.

Full Explanation:

This column contains the Equinox 2000.0 Declination in degrees (°), arc minutes ('), and arc seconds (") for the object. The original NGC's Equinox was for 1860.0, which is not very useful for accurately locating the objects today, but was also in NPD format. NPD format is *North Polar Declination* format, and assumes that the North celestial pole is at 0°, and the South celestial pole is at +180°, with the celestial equator being at +90°. This differs from our current Standard Equatorial format which places the North celestial pole at +90°, the South celestial pole at -90°, and the equator at 0°. This Standard Equatorial format is the format shown in this column.

Harold G. Corwin originally derives all of the DEC positions in this table from B1950.0 positions as published in the Accurate Positions Files. The B1950.0 Equinox positions were precessed to J2000.0 Equinox using Newcomb's rigorous precession engine algorithm. All positions were then verified (validated) against images generated from the Digitized Sky Survey (DSS-I and DSS-II). As a side note, it should be noted that the difference between Equinox 2000.0 and Julian Equinox 2000.0 (J2000) is only noted in the hundredths of a Right Ascension (RA) second, and tenths of a Declination (DEC) arc second. Both positions yield the same center pixel in a DSS image. Since the Project's positions only go to the nearest tenth of an RA second and the nearest DEC arc second, there is usually no difference between Equinox 2000.0 positions and Julian Equinox 2000.0 positions.

Column Name: Const
Column: 90

Concise Explanation:

This column contains the abbreviation for the constellation in which the object is to be found.

Full Explanation:

This column contains the abbreviation for the constellation in which the object is to be found. The International Astronomical Union (IAU) has defined 88 constellations to cover the entire sky, which we have mostly adopted, with the exception being that the constellation Serpens has been broken into two separate designations which match its placement in the night sky. The constellation Serpens actually occupies two separate and distinct regions of the sky which represent the head of the serpent (Serpens Caput), and the tail of the serpent (Serpens Cauda), and so for the purpose of this project we refer to them as SerCp and SerCd respectively. The table of constellation abbreviation to constellation full name is shown below:

Abbr	Full Name	Abbr	Full Name
And	Andromeda	Leo	Leo
Ant	Antlia	LMi	Leo Minor
Aps	Apus	Lep	Lepus
Aqr	Aquarius	Lib	Libra
Aql	Aquila	Lup	Lupus
Ara	Ara	Lyn	Lynx
Ari	Aries	Lyr	Lyra
Aur	Auriga	Men	Mensa
Boo	Boötes	Mic	Microscopium
Cae	Caelum	Mon	Monoceros
Cam	Camelopardalis	Mus	Musca
Cnc	Cancer	Nor	Norma
Cvn	Canes Venatici	Oct	Octans
CMa	Canis Major	Oph	Ophiuchus
CMi	Canis Minor	Ori	Orion
Cap	Capricornus	Pav	Pavo
Car	Carina	Peg	Pegasus
Cas	Cassiopeia	Per	Perseus
Cen	Centaurus	Phe	Phoenix
Cep	Cepheus	Pic	Pictor
Cet	Cetus	Psc	Pisces
Cha	Chamaeleon	PsA	Piscis Austrinus
Cir	Circinus	Pup	Puppis
Col	Columba	Pyx	Pyxis
Com	Coma Berenices	Ret	Reticulum
CrA	Corona Australis	Sge	Sagitta
CrB	Corona Borealis	Sgr	Sagittarius
Crv	Corvus	Sco	Scorpius
Crt	Crater	Scl	Sculptor
Cru	Crux	Sct	Scutum
Cyg	Cygnus	SerCp	Serpens Caput
Del	Delphinus	SerCd	Serpens Cauda
Dor	Dorado	Sex	Sextans
Dra	Draco	Tau	Taurus
Equ	Equuleus	Tel	Telescopium
Eri	Eridanus	Tri	Triangulum
For	Fornax	TrA	Triangulum Australe
Gem	Gemini	Tuc	Tucana
Gru	Grus	UMa	Ursa Major
Her	Hercules	UMi	Ursa Minor
Hor	Horologium	Vel	Vela
Hya	Hydra	Vir	Virgo
Hyi	Hydrus	Vol	Volans
Ind	Indus	Vul	Vulpecula
Lac	Lacerta		

Column Name: Original NGC Summary Description
Column: 97

Concise Explanation:

This column contains the "Summary Description" as published in the original NGC.

Full Explanation:

This column contains the "Summary Description" as published in the original NGC. These descriptions, mostly by the original discoverer, are done in an abbreviated language used by astronomers of that period, and the "decoding" table is shown below. These Summary Descriptions for each NGC object were hand entered into the Project's database by Bob Erdmann over the period of 1993 up until now (working sporadically, as time permitted). J.L.E. Dryer, in the original NGC, writes:

The "Summary Description" of objects not occuring in the General Catalogue represents the observer's own words as nearly as possible, except that I have always changed M. STEPHAN'S *eeF* into *eF*, and *eF* into *vF*, as such of his novae which have been found independently by other observers have always by these been described as somewhat brighter than by M. STEPHAN. The system of abbreviated description used in the observations of the two HERSCHELS has been in use so long that it is uunnecessaryto enter into a lengthy explanation of it, except to call attention to the progressive scale of brightness, size, and form adopted by Sir JOHN HERSCHEL.

```
 1. excessively faint     excessively small, 3" to 4" diam.
 2. very faint            very small, 10" to 12" diam.
 3. faint                 small, 20" to 30" diam.
 4. considerably faint    considerably small, 20" to 30" diam.
 5. pretty faint          pretty small, 50" to 60" diam.
 6. pretty bright         pretty large, 50" to 60" diam.
 7. considerably bright   considerably large, 3' to 4' diam.
 8. bright                large, 3' to 4' diam.
 9. very bright           very large, 8' to 10' diam.
10. excessively bright    excessively large, 20' and upwards.*
```

* In estimating clusters of well-separated and scattered stars a wider acceptation must be understood, so that, e.g., a cluster of 1' in extent would be very small, and one of 15' or 20' large.

In the case of form, the scale was supposed arranged in the order: round, very little extended, elliptic or oval, considerably extended, pretty much extended, much extended, very much extended, extremely extended.

The following is a complete list of the abbreviations:

Ab.............about
alm.............almost
am..............among
app.............appended
att.............attached
b...............brighter
be..............between
biN.............binuclear
bn..............brightest towards the north side
bs..............brightest towards the south side
bp..............brightest towards the preceding side
bf..............brightest towards the following side
B...............bright
c...............considerably
ch..............chevelure
co..............coarse, coarsely
com.............cometic
cont............in contact
C...............compressed
C.G.H...........Cape of Good Hope
Cl..............cluster
d...............diameter
def.............defined
dif.............diffused
diffic..........difficult
dist............distance or distant
D...............double
e...............extremely, excessively
ee..............most extremely
er..............easily resolvable
exc.............excentric
E...............extended
f...............following
F...............faint
g...............gradually
gr..............group
i...............irregular
inv.............involved,involving
iF..............irregular figure
l...............little,long
L...............large
m...............much

n.............north
neb.............nebula
nf..............north following
np..............north preceding
nr..............near
N...............Nucleus, or to a Nucleus
p...............pretty (before F,B,L,S)
p...............preceding
pg..............pretty gradually
pm..............pretty much
ps..............pretty suddenly
P...............poor
quad............quadrilateral
quar............quartile
r...............resolvable (mottled,not resolved)
rr..............partially relolved, some stars seen
rrr.............well resolved, clearly consisting of stars
R...............round
RR..............exactly round
Ri..............rich
s...............suddenly
s...............south
sp..............south preceding
sf..............south following
sc..............scattered
st..............stars
sev.............several
susp............suspected
sh..............shaped
stell...........stellar
S...............small
sm..............smaller
triN............trinuclear
trap............trapezium
v...............very
vv..............very, very
var.............variable
*...............a star: *10, a star of 10th magnitude
**..............double star
***.............triple star
!...............remarkable
!!..............very remarkable
!!!.............a magnificent or otherwise interesting

mm..............mixed magnitudes
mn..............milky nebulosity
M...............middle, or in the middle

object
st 9… ....stars from the 9th magnitude downwards
st 9…13 ....stars from the 9th to 13th magnitude

--------------- Object Types -----------------------------

AN..............Annular (ring) Nebulæ
GC..............Globular Cluster
PN..............Planetary Nebulæ

An example of the usage of these shorthand tools, and what the resultant translation would be, is:

"GC, vB, vL, eCM, rrr, st S" - (This is from NGC 6341)

which results in a translation of:

"Globular Cluster, very bright, very large, extremely compressed in the middle, well resolved, clearly consisting of small stars"

Column Name: Discoverer
Column: 155

Concise Explanation:

This column contains the name of the original discoverer of the object.

Full Explanation:

This column contains the name of the original discoverer of the object. There were more than 100 different discoverers of objects which made their way into the original NGC. Some observers only account for one object, or just a couple of them. At the other end is William Herschel who discovered 2421 objects which made their way into the original NGC, and was closely followed by his son, John Herschel, who accounts for 1692 additional objects being added to the NGC. These two observers account for over 52% of the objects to be found in the original NGC, and is testimony to their prowess at the eyepiece of a telescope, the weather in England notwithstanding.

Column Name: Year
Column: 179

Concise Explanation:

This column contains the year in which the discovery of the object took place.

Full Explanation:

This column contains the year in which the discovery of the object took place. In the course of my research and Harold Corwin's research, only a window of a couple of years could be pinned down, but these are but for a scant few objects. All of this "year of discovery" information was derived from the original publications of their work as published at the time. The Project does have day and month discovery information as well, but for the purposes of this listing, I felt that the year was sufficient. If there is enough interest, I will also publish the day and month discovery information as well.

Column Name: Telescope Type
Column: 187

Concise Explanation:

This column contains the type of telescope used for the discovery of the object.

Full Explanation:

This column contains the type of telescope used for the discovery of the object, and was compiled from published papers of the time, mostly by the original observers themselves, or from information published by the observatory in which the observers worked. Only two basic types are listed (Reflector & Refractor), as information beyond that was not readily found for each of the discoverers.

Column Name: Diam (inch)
Column: 198

Concise Explanation:

This column contains the aperture of the telescope used for the object's discovery.

Full Explanation:

This column contains the aperture of the telescope used for the object's discovery, in inches when it could be found. These numbers range from 0.27 inches (naked eye) for NGC 224 and NGC 292, all the way to the 72-inch **Leviathan** at Birr Castle, used by Lord Rosse, his staff, and occasionally by Dryer himself.

Column Name: Object Type
Column: 206

Concise Explanation:

This column contains the an abbreviation for the basic type of object associated with the NGC designation.

Full Explanation:

This column contains the an abbreviation for the basic type of object associated with the NGC designation. A list of these abbreviations is shown below:

Abbrev	Description	Example
*	Single Star	NGC 3797
**	Double Star	NGC 8
***	Triple Star	NGC 4397
Ast	Asterism	NGC 305
Gxy	Galaxy	NGC 3320
GxyCld	Bright cloud/knot in a galaxy	NGC 5447
GC	Globular Cluster	NGC 104
HIIRgn	HII Region	NGC 5000
Neb	Nebula (emission or reflection)	NGC 248
NF	Not Found	NGC 412
OC	Open Cluster	NGC 411
PN	Planetary Nebula	NGC 40
SNR	Supernova Remnant	NGC 1918
MWSC	Milky Way Star Cloud	NGC 6227

Sometimes, the object being referred to is a combination of two or more of the basic objects from the table above. An example would be NGC 3324, an open cluster with nebulosity associated with it, which would be referred to as "OC+Neb"

Column Name: Object Classif
Column: 213

Concise Explanation:

This column contains the classification of the object for its object type.

Full Explanation:

This column contains the classification of the object for its object type. In the case of galaxies, this would be the Revised Morphological Types as shown in the *Third Reference Catalogue of Bright Galaxies* by de Vaucouleurs, de Vaucouleurs, Corwin, Buta, et al., Volume I, page 15. In the case of Open Clusters, the Trumpler classification system is used as shown in *Open Star Clusters* by Benjamin Jones, **http://www.astroleague.org/al/obsclubs/opencluster/OC_Manual.pdf**. For Globular Clusters, the Shapley-Sawyer concentration class of 1 - 12 (I - XII) is used. (Class I globulars are the most concentrated and have a high surface brightness, while Class XII are low-surface-brightness loose clusters.). For Planetary Nebula, the Voroncov-Vel'jaminov classification system is used as shown in the Catalogue of Galactic Planetary Nebulae by Perek & Kohoutek (1967), page 13.

Column Name: Size
Column: 228

Concise Explanation:

This column contains the size of the object, usually in arcminutes.

Full Explanation:

This column contains the size of the object. The format is major diameter X minor diameter, with both diameters in arc minutes e.g. 10.2'X8.7'. The sources of this data are numerous, and include (but not limited to) major object catalogs (UGC, MCG, CGCG, ESO, PGC, GCL, OCL, Lund, PK, etc.), and direct measurement from images generated from the 102-CD set of the 1st Generation Digitized Sky Survey (DSS-I), as well as the 2nd Generation Digitized Sky Survey (DSS-II) available at **http://archive.eso.org/dss/dss/**. Several thousand random checks, over the course of the project, were made using the DSS against the published sizes from major galaxy catalogs as a sort of "sanity check", with only a handful of changes resulting. In some cases, where the identified NGC object had no reliably cataloged size, a direct measurement took place from the DSS using extreme histogram re-mapping to accentuate the outer faint reaches of the object to increase the overall accuracy of the measurement. The result is that sizes should be reasonably close for most comparisons.

Column Name: PA°
Column: 240

Concise Explanation:

This column contains the position angle of the object in degrees.

Full Explanation:

This column contains the position angle of the object in degrees. This is used only for galaxies, which are the majority of the objects in the NGC, and hence the HCNGC. It is measured from North, rotating eastwards until South is reached. This defines the allowable range of position angles to be from 0° to 179°, as 180° would be identical to 0°. The source for this information is mostly the major galaxy catalogs, but in a substantial number of objects, it was not even available in those sources. In those cases, position angles were measured directly from the Digitized Sky Survey images, with a resulting maximum error of around 5°, due mostly to uncertainties in determining the exact vector direction to the North Celestial Pole relative to the orientation of the DSS image.

Column Name: Vmag
Column: 246

Concise Explanation:

This column contains the visual magnitude of the object.

Full Explanation:

This column contains the visual magnitude of the object. For Galaxies, it comes either directly or calculated from either the electronic version of Third Reference Catalogue of Bright Galaxies by de Vaucouleurs, de Vaucouleurs, Corwin, Buta, et al., or the electronic version of the Surface Photometry Catalog of the ESO-Uppsala by Lauberts & Valentijn. They were merged together into one large catalogue of 38,434 galaxies to be able to easily do the number crunching. Other types of objects' Vmag numbers come from any number of different sources, most of which are professional catalogs of their respective object type i.e. PK, Lund, ESO, etc.

Column Name: Bmag
Column: 253

Concise Explanation:

This column contains the blue magnitude of the object.

Full Explanation:

This column contains the blue magnitude of the object. For Galaxies, it comes directly or calculated from either the electronic version of Third Reference Catalogue of Bright Galaxies by de Vaucouleurs, de Vaucouleurs, Corwin, Buta, et al., or the electronic version of the Surface Photometry Catalog of the ESO-Uppsala Galaxies by Lauberts & Valentijn. They were merged together into one large catalogue of 38,434 galaxies to be able to easily do the number crunching. Other types of objects' Bmag numbers come from any number of different sources, most of which are professional catalogs of their respective object type i.e. PK, Lund, ESO, etc.

Column Name: VSfc Brt
Column: 260

Concise Explanation:

This column contains the calculated visual surface brightness of the galaxy.

Full Explanation:

This column contains the calculated visual surface brightness of the galaxy. The values needed for the calculation were extracted from combining the electronic version of Third Reference Catalogue of Bright Galaxies (RC3) by de Vaucouleurs, de Vaucouleurs, Corwin, Buta, et al., and the electronic version of the Surface Photometry Catalog of the ESO-Uppsala Galaxies (ESO-LV) by Lauberts & Valentijn. Both of these catalogs were supplied by Dr. Harold G. Corwin, Jr. of NASA's Extra-galactic Database Program (NED). They were merged together into one large catalogue of 38,434 galaxies to be able to easily do the parameter extraction and subsequent calculations.

The methodology for calculating the visual surface brightness (V'_{25}) comes from the Third Reference Catalogue of Bright Galaxies (RC3) , Volume 1, page 10, and for our purposes can be reduced to the following equation.

$V'_{25} = V_T + \mathrm{DeltaV} + 5\mathrm{Log}D - 2.5\mathrm{Log}(D/d) - 0.26$

where V_T = total V magnitude,
DeltaV = 0.25 for cD or E type galaxies (T = -6 to -4),
DeltaV = 0.13 for $S0^-$, S0, and $S0^+$ type galaxies (T = -3 to -1),
DeltaV = 0.11 for all other galaxy types (T > or = 0),
D = major axis in arc minutes, and
d = minor axis in arc minutes.

The value of DeltaV is determined by the revised morphological type of the galaxy of interest, and a table of "T" values for the various morphological types is shown in RC3, Volume 1, page 15. In some instances, the total V magnitude of the galaxy was not available, and so had to be calculated using

Vt = (B-V)=(B-R)/1.5 - 0.1

But some galaxies had no (B-V) parameter in either RC3 or ESO-LV, and so had to be determined from "Mean Morphological Types of Bright Galaxies" by R. Buta as published in The Astronomical Journal, Volume 107, Number 1, Table VI, which shows T versus (B-V). In some cases a particular NGC galaxy was not included in either RC3 or ESO-LV, and so visual surface brightness calculations for those galaxies had to be done on an individual basis using other sources of photometric data available from sources such as the Sloan Digitized Sky Survey (SDSS), lesser known galaxy catalogs, individual scientific papers, etc.

Assuming no individual study errors, errors in the magnitudes themselves are somewhere around 0.4 in the north and 0.25 in the south. Errors in the diameters are somewhere around 10% in the north, and 7% in the south. These translate into about 0.5 mag and 0.35 magnitude respectively. Axis ratio errors are a little better in percentage terms (7% north, 5% south), and translate into 0.18 and 0.13 magnitudes, respectively. Adding these quadradically gives visual surface brightness errors of roughly 0.7 and 0.5 magnitudes in the north and south, respectively. The end result is that visual surface brightness numbers are not absolute, but should be usable to determine relative visual surface brightnesses between objects, and give the user a better feel for whether an object would be viewable in a particular size telescope, assuming they use other magnitude and atmospheric information in the determination as well.

Column Name: NGC Equiv
Column: 266

Concise Explanation:

This column lists other equivalent NGC designations for the object.

Full Explanation:

This column lists other equivalent NGC designations for the object. This is the result of errors of identification in the original NGC back in the 1880's when the NGC was being compiled, and these equivalencies are the result of research work by members of The NGC/IC Project, as well as those who came before us, including Dreyer himself, who not only published NGC corrections in the notes section of the two Index Catalogs (IC's), but published a stand-alone set of corrections in a 1912 paper.

Examples are NGC 6 = NGC 20, NGC 17 = NGC 34, NGC 3100 = NGC 3103, etc.

Column Name: IC Equiv
Column: 281

Concise Explanation:

This column lists equivalent IC designations for the object.

Full Explanation:

This column lists equivalent IC designations for the object. This is the result of errors of iidentification in the original IC's back in the late 1880's and early 1900's when the IC's were being compiled, and the uncovering of these equivalencies are the result of research work by members of The NGC/IC Project as well as those who came before us.

Examples are NGC 70 = IC 1539, NGC 135 = IC 26, NGC 3113 = IC 3588, etc.

Column Name: Also Cataloged As
Column: 292

Concise Explanation:

This column contains most of the other major catalog designations for the object.

Full Explanation:

This column contains most of the other major catalog designations for the object. It is by no means complete in its scope, but should include most of the major object catalogs and even some of the minor ones as well. Either hard copy versions or electronic versions of these catalogues were, and are, being used throughout the course of this project with some exceptions. The major and minor catalogs to be found in this column are:

Desig	Catalog Name
3C	Third Cambridge Catalog of Radio Sources by D.O. Edge et al - 1959
A	Anonymous - Second Reference Catalogue of Bright Galaxies by A & G de Vaucouleurs, H.C. Corwin - 1976
Abell	Properties of Some Old Planetary Nebulae by G.O. Abell - 1966
AM	A Catalogue of Southern Peculiar Galaxies and Associations by H. C. Arp & B. F. Madore - 1987
ARAK	Galaxies of high surface brightness by M.A. Arakelian - 1975
ARP	Atlas of Peculiar Galaxies by H. C. Arp - 1966
Berkeley	Catalogue of Star Clusters and Associations by U.C. Berkeley – 1958
Bochum	Catalog of Star Clusters by Astronomical Institute, Ruhr Univ., Bochum,Germany - 1975
CED	Catalog of Bright Diffuse Galactic Nebulae by S. Cederblad - 1946
CGCG	Catalogue of Galaxies and Clusters of Galaxies by F. Zwicky et al - 1963 to 1968
CGMW	Catalogue of Galaxies Behind the Milky Way by M. Saito et al – 1990
Cr	On Structured Properties of Open Galactic Clusters ... by P. Collinder - 1931
DRCG	Clusters and Superclusters of Galaxies by Dressler et al - 1999
ESO	ESO/Uppsala Survey of the ESO(B)-Atlas by A. Lauberts - 1982
FAIR	Southern Compact and Bright Nucleus Galaxies by A.P. Fairall - 1977 to 1988
Fath	The Spectra of Spiral Nebulae and Globular Star Clusters by E.A. Fath - 1913
FCC	A catalog of galaxies in the central 3.5 degs of the Fornax Cluster by H. C. Ferguson - 1989
FGC	Flat Galaxy Catalogue by I. D. Karachentsev, V. E. Karachentseva, & S. L. Parnovsky - 1993
GCL	Catalogue of Star Clusters and Associations by J. Ruprecht, B. Balazs, & R. E. White - 1981
Gum	A Survey of Southern H II Regions by C. S. Gum - 1955
HARO	Preliminary Note on Blue Galaxies With Emission Lines by G. Haro – 1956
Holm	Catalog of Dwarf Galaxies by Holmberg - 1974
Hick	A Photometric Catalog of Compact Groups of Galaxies by P. Hickson - 1985
IRAS	Cataloged Galaxies and Quasars Observed in the IRAS Survey by C. J. Lonsdale et al - 1989
KARA	Catalogue of Isolated Galaxies by V. E. Karachentseva - 1973
KAZ	New galaxies with ultraviolet excess by M. A. Kazayan and G. V. Kazayan - 1979 to 1983
KCPG	Catalog of Isolated Pairs of Galaxies by I. Karachentsev - 1987
KDWG	A list of new nearby dwarf galaxy candidates by V.E. Karachentseva, I.D. Karachentsev - 1998
KMH90	The cluster system of the Large Magellanic Cloud by M. Kontizas, D. H. Morgan, D. Hatzidimitriou - 1990.
KUG	Kiso Survey for Ultraviolet-Excess Galaxies by B. Takase, N. Miyauchi-Isobe - 1984 to 1993
LBN	Catalogue of Bright Nebulae by B.T. Lynds - 1965
LDN	Catalogue of Dark Nebulae by B.T. Lynds - 1962
LGG	Lyon Group of Galaxies Catalogue by A.M. Garcia - 1993
LT	Possible Ring Galaxies Near Rich Clusters by L.A. Thompson - 1977
Lund	Catalogue of Open Cluster Data by G. Lynga - 1987
M	Catalogue Des Nebuleuses et Des Amas D'etoiles by C. Messier – 1781
MCG	Morphological Catalogue of Galaxies by B. A. Vorontsov-Velyaminov, V. P. Arkhipova - 1962 to 1968
Mel	A catalogue of star clusters shown on the Franklin-Adams chart plates by P. J. Melotte - 1915

Mrk..........Catalogue of Galaxies with Ultraviolet Continuum by B.E. Markarian et al - 1967 to 1981

NPM1G........Lick Northern Proper Motion Program, First List of Galaxies by A.R. Klemola et al - 1987

OCL..........Catalogue of Star Clusters and Associations. III. Open Clusters by J. Ruprecht, B. Balazs, & R. E. White - 1981

Pal..........Globular Clusters and Planetary Nebulae Discovered on the NGS-POSS by G.O. Abell - 1955

Parsamyan....Catalogue of Cometary Nebulae Discovered on Palomar Maps by E.S. Parsamian - 1965

PGC..........Principal Galaxies Catalogue by G. Paturel, P. Fouque, L. Botinelli and L. Gougenheim - 1989

Pismis.......Nuevos Cumulos Estelares en Regiones del Sur by P. Pismis - 1959

PK...........Catalog of Galactic Planetary Nebulae by L. Perek and L. Kohoutek - 1967

PN...........Strasbourg-ESO Catalogue of Galactic Planetary Nebulae by A. Acker et al - 1992

PP...........Catalogue of Cometary Nebulae and Related Objects by E.S. Parsamian, V.M. Petrosian - 1979

PRC..........An HI Survey of Polar Ring Galaxies by W. K. Huchtmeier - 1997

RB...........Photographic Brightness Profiles of Coma Cluster Galaxies I & II by H.J. Rood, W.A. Baum - 1968

RCW..........Catalog of HII regions by Rodgers, Campbell & Whiteoak - 1960

Ru...........Classification of open star clusters by J. Ruprecht - 1966

SBS..........Faint Markarian galaxies of SBS. III. by J.A. Stepanian - 2002

SG...........Catalogue of emission nebulae by G.A. Shajn, V.F. Gaze - 1955

Sh2..........A Catalogue of H II Regions by S. Sharpless - 1959

Shkh.........Compact groups of compact galaxies by R.K. Shakhbazian - 1996

SS...........Notes on Diffuse Galactic Nebulae by Otto Struve, W.C. Straka – 1962

Todd.........Telescopic Search for the Trans-Neptunian Planet by David P. Todd - 1886

TOL..........Tololo List of Galaxies by M.G. Smith, C. Aguirre, M. Zemelan – 1976

UA...........Catalogue of Selected Non-UGC Galaxies by P. Nilson - 1974

UGC..........Uppsala General Catalogue of Galaxies by P. Nilson - 1973

UM...........Curtis Schmidt-Thin Prism Survey for Extragalactic Emission-Line Objects by G. M. MacAlpine et al - 1977 to 1982

URA..........Supplement List of Stellar Rings I & II by T.A. Uranova - 1973

VCC..........The Virgo Cluster Catalog (VCC) by B. Binggeli, A. Sandage, G.A. Tammann - 1985

VdB..........Catalogue of Reflection Nebulae by Van den Bergh - 1996

VV...........The Atlas and Catalogue of Interacting Galaxies by Vorontsov-Vel'yaminov - 1959

WBL..........A Catalog of Nearby Poor Clusters of Galaxies by R.A. White et al – 1999

Column Name: Historical Notes
Column: 400

Concise Explanation:

This column contains the initials of the researcher who has an historical note about the object

Full Explanation:

This column contains the initials of the researchers who have an historical note about the object. Multiple sets of initials can appear in this column if multiple historical notes exist for the object. The initials of the relevant researchers are:

H.C. = Dr. Harold G. Corwin, Jr.
M.T. = Malcolm Thomson
R.E. = Robert Erdmann

Most of the historical notes for the NGCs are the work of Dr. Harold G. Corwin, Jr., who has spent decades compiling and researching the historical puzzles associated with the NGCs. If his ititials appear in this column for a given object, then his relevant note is available for viewing on this web site, under the heading "Historical Notes Files".

If Malcolm Thomson's initials appear in this column, his historical note for the object is available on this web site under the heading "The Survey - List of Corrections ...", and it should be further noted that this applies to NGC objects which have an IC designation identity, as Malcolm's list of corrections is ordered by IC designation. An example would be NGC 6679, which also has an IC identity of IC 4763.

If my initials (Robert Erdmann - R.E.) appear in this column, it indicates that I did some additional research and included it in the Project's database. This is a rare occurance, but an example would be NGC 598 (M33) where I researched the additional IC objects associated with NGC 598, wrote an historical note, and annotated the DSS image of NGC 598. Since I did not create a text list, as Dr. Corwin and Malcolm Thomson have done, the best way to see this type of historical note is to go to the web page for the particular object and scroll down to the "Historical Note" section of the web page

---

Column Name: Observing Notes
Column: 420

Concise Explanation:

This column contains the initials of the observer who observed the object and generated an observing note for it.

Full Explanation:

This column contains the initials of the observer who observed the object and generated an observing note for it. At this point in time, the only initials to be found in this column are those of Steve Gottlieb (S.G.) who has generated observing notes for 6,571 different NGC objects, which is an amazing feat! Steve, who mostly observes from California, has taken numerous trips to Costa Rica & Australia in order to observe the southern objects not visible from his home in California. Steve's observing notes may be viewed on the Project's web site under Team Members Databases.

Column Name: Uranometria 2000.0 Chart Numbers
Column: 437

Concise Explanation:

This column contains all of the Uranometria 2000.0 chart numbers upon which the object should be plotted.

Full Explanation:

This column contains all of the Uranometria 2000.0 chart numbers upon which the object is plotted, or should be plotted. In other words, because of the nature of the HCNGC (82 non-existent objects), and the fact that Uranometria 2000.0 used a machine readable copy of the RNGC (793 non-existent objects) for one of its databases of non-stellar objects, there will be a number of disagreements between Uranometria 2000.0 and HCNGC. What I have tried to do is to designate the chart numbers that each of the 7,840 HCNGC objects would be plotted on if they were plotted on the Uranometria 2000.0 charts. In some cases you will find up to four (4) chart numbers containing the object of interest. This is due to the overlapping nature of the corner/edge coordinates of the Uranometria 2000 charts, and so in some cases, depending upon the coordinates of the object, it is actually plotted upon four different charts in the overlap areas.

It should also be noted that the Uranometria 2000.0 chart numbers are for those printings of the charts authored by Tirion, Rappaport & Lovi, and are not for the most recent printings authored by Tirion, Rappaport & Remaklus in which the charts were substantially re-numbered. The reason that the HCNGC supports the Tirion, Rappaport & Lovi printings and not the Tirion, Rappaport & Remaklus printings is that I own two sets of the former and none of the latter, thus it is but a financial consideration only.

Column Name: Herald-Bobroff ASTROATLAS
Column: 457

Concise Explanation:

This column contains all of the Herald-Bobroff ASTROATLAS chart numbers upon which the object should be plotted.

Full Explanation:

This column contains all of the Herald-Bobroff ASTROATLAS chart numbers upon which the object should be plotted. In this case, David Herald and Peter Bobroff (who personally gave me a copy of their superb charts) used various databases, depending upon object type, for object plotting. In the case of galaxies, they used a copy of *Catalogue of Principal Galaxies (PGC)* by Paturel et al; for Globular Clusters they used *Globular Star Clusters* by B.V. Kukarkin, etc. What I have tried to do is to designate the chart numbers that each of the 7,840 HCNGC objects would be plotted on if they were plotted on the ASTROATLAS charts. In some cases, you will find up to nine (9) chart numbers containing the object of interest. This is not only due the the overlapping nature of the charts, but also because some areas of the sky, due to the large concentration of objects, have additional zoomed charts for better object coverage i.e. The Virgo galaxy cluster, LMC, SMC, etc.

Because of the nature of all of the different charts and chart types, I will not go into a full explanation here, but if you possess a copy of the ASTROATLAS, these chart numbers should be quite useful.

Column Name: GSC Small Region Nr
Column: 507

Concise Explanation:

This column contains the Hubble Guide Star Catalog (GSC) Small Region Number for the object.

Full Explanation:

This column contains the Hubble GSC Small Region Number for the object. There are 9537 small regions within the Hubble GSC, and knowing which one is appropriate for the object of interest can substantially shorten the access time into the Hubble GSC to obtain accurate object positional data.

Additional information about the Hubble GSC, and small region numbers, can be found at:

The Astronomical Journal, Volume 99, Number 6, June 1990, Barry M. Lasker et al, pages 2019 to 2081
The Astronomical Journal, Volume 99, Number 6, June 1990, Helmut Jenkner et al, pages 2082 to 2097.

Column Name: POSS Blue Plate Nr
Column: 520

Concise Explanation:

This column contains the POSS Blue plate/print number containing the object.

Full Explanation:

This column contains the POSS Blue plate/print number containing the object. The full nomenclature of the photographic survey is "National Geographic Society - Palomar Observatory Sky Atlass", and was done from 1949 to 1958 using the 48-inch Palomar Schmidt telescope. Two emulsions were used, a red sensitive Kodak 103a-E, and a blue sensitive Kodak 103a-O, thus resulting in both blue and red sensitive plates/prints of the same piece of the sky. For the most part, blue plate numbers are the same as the red plate numbers, but there are four instances where the blue plate number is not the same as the red plate number. These differences are shown in the table below:

Red Plate Number	Blue Plate Number
9	10
14	15
15	16
11	12

This column, and the Red Plate/Print Number column are mainly for those who either possess a copy of the POSS prints, or who through their association with an observatory, university, or library have access to the POSS prints.
For additional information on the POSS, see *"A User's Guide to the Palomar Sky Survey"* by James M Lund and Robert S Dixon, Publications of the Astronomical Society of the Pacific, Volume 85, Number 504, April 1973, page 230.

Column Name: POSS Red Plate Nr
Column: 532

Concise Explanation:

This column contains the POSS Red plate/print number containing the object.

Full Explanation:

This column contains the POSS Red plate/print number containing the object. The full nomenclature of the photographic survey is "National Geographic Society - Palomar Observatory Sky Atlass", and was done from 1949 to 1958 using the 48-inch Palomar Schmidt telescope. Two emulsions were used, a red sensitive Kodak 103a-E, and a blue sensitive Kodak 103a-O, thus resulting in both blue and red sensitive plates/prints of the same piece of the sky. For the most part, blue plate numbers are the same as the red plate numbers, but there are four instances where the blue plate number is not the same as the red plate number. These differences are shown in the table below:

Red Plate Number	Blue Plate Number
9	10
14	15
15	16
11	12

This column, and the Blue Plate/Print Number column are mainly for those who either possess a copy of the POSS prints, or who through their association with an observatory, university, or library have access to the POSS prints.
For additional information on the POSS, see *"A User's Guide to the Palomar Sky Survey"* by James M Lund and Robert S Dixon, Publications of the Astronomical Society of the Pacific, Volume 85, Number 504, April 1973, page 230.

Column Name: Sources Used
Column: 544

Concise Explanation:

This column contains references to all of the major sources used to research the object.

Full Explanation:

This column contains all of the major sources used to research the object. These major sources span from major object catalogues, DSS images, on-line databases, as well as private e-mail and face-to-face communications. What is not included in this column are any references to the historical literature, consisting of photocopies of original published papers and notes by the discoverer of the object collected over the years by Dr. Corwin. These may be added at a later date when time is more available, but are available now in the Introduction section of the original NGC should the user want to dig them out. Some of those historical papers and notes are scanned and posted on the Project's web site in the Historical Record section. The table of abbreviations, corresponding to the sources used, is as follows:

```
A = [CSPGA] A Catalogue of Southern Peculiar Galaxies and Associations
    (Arp & Madore - 1987)
a = [RNGCA] RNGC Errata (Archinal)
B = [WSQJ#104] A New Catalogue of Visual Magnitudes for Planetary
    Nebulae (Brazell)
b = [BAS1] Pvt. Letter (Skiff 2/20/92)
C = [SGC] Southern Galaxy Catalog (Corwin, de Vaucouleurs, de
    Vaucouleurs - 1985)
c = [RNGCC] RNGC Errata (Corwin)
D = [DSS1-2] Digitized Sky Survey - 1st & 2nd Generation (STScI - 1994)
d = [NGC6166] NGC 6166 and the cluster Abell 2199 (Minkowski - 1961)
E = [ESO] The ESO Uppsala Survey of the ESO(B) Atlas (Lauberts - 1982)
e = [MRK] Catalog of Galaxies with Ultr-Violet Continuum (Markarian)
F = [FGC] Flat Galaxy Catalogue (Karachentsev - 1993)
f = [GD-AA] Ancient Astronomers list (George DeLange - 2006]
G = [AGC] Abell Galaxy Cluster Catalog (G. Abell)
g = [GOTT1] Pvt. Letter (Gottlieb 1/6/92)
H = [HGCJ1] Pvt. Letter (Corwin 8/7/91)
h = [SL] Shapley-Lindsay LMC Catalog
I = [IRAS] IRAS Survey (NASA - 1989)
J = [CPMWGC] Catalog of Parameters for Milky Way Globular Clusters
    (Harris)
j = [CSRG-RB] Catalog of Southern Ringed Galaxies (R. J. Buta - 1995)
L = [LUND] Lund Catalog of Open Clusters (Lynga)
l = [LBN] Catalog of Bright Nebula (Lynds)
K = [KMH90] The Cluster System Of The Large Magellanic Cloud (Kontizas
    - 1990)
M = [MOL] Master List of Nonstellar Optical Astronomical Objects (Dixon
    & Sonneborn - 1980)
m = [MCG] Morphological Catalog of Galaxies (Vorontsov-Velyaminov et al
    - 1962 thru 1968)
N = [NGC] New General Catalogue / [IC] Index Catalogue (Dreyer - 1888,
    1895, 1908)
n = [NED] NASA's Extragalactic Database (NED) located at
    http://nedwww.ipac.caltech.edu/index.html
O = [OHCDSO] Observing Handbook and Catalog of Deep-Sky Objects
    (Luginbuhl & Skiff - 1990)
P = [PK] Catalog of Galactic Planetary Nebulae (Perek & Kohoutek)
p = [SCGPN] Strasbourg Catalog of Galactic Planetary Nebula (Acker)
Q = [GD-NGCDDB] NGC Discoverer's Database (DeLange - 1987 to 2006)
q = [M&KMessier] The Messier Album (Mallas & Kreimer - 1978)
```

R = [SA] Revised Shapley-Ames Catalog
r = [ICMT] Corrected IC Catalogues Database (Malcolm J Thomson - 2005)
S = [RE-NGCDDB] NGC Discoverer's Database (Erdmann 1990 - 2006)
s = [SH2] A Catalogue of H II Regions (Sharpless)
T = [NGCT] The Nearby Galaxies Catalog (Tully
t = [NS] Navigation Stars (Mote)
U = [UGC] Uppsala General Catalog of Galaxies (Nilson - 1973)
u = [UGCE] UGC Errata (Erdmann - 1989)
V = [GN] Atlas of Galactic Nebulae (Vehrenberg)
W = [WSQJ#105] Precise Positions for the NGC/IC Planetary Nebulae (Skiff)
X = [WSQJ#99] Observational Data for Galactic Globular Clusters (Skiff)
x = [NESC-RNGC] The Non-Existent Star Clusters of the RNGC (Archinal – 1993)
Z = [CGCG] Catalog of Galaxies & Clusters of Galaxies (Zwicky - 1968)
z = [BAS2] Pvt. Letter (Skiff 2/18/93)
0 = [RE-AZDB] The Arizona Database®, V15.5 (Erdmann - 1987 thru 2005)
1 = [ARP] Atlas of Peculiar Galaxies (H. Arp)
2 = [HC-HNDB] NGC Historical Notes Databases (Corwin - 1996 thru 2006)
3 = [RC3] Third Reference Catalogue of Bright Galaxies (de Vaucouleurs, de Vaucouleurs, Corwin, Buta, et. al. - 1991)
4 = [ESO-LV] The Surface Photometry Catalog Of The ESO-Uppsala Galaxies (Lauberts & Valentijn - 1989)
5 = [PGC] Principle Galaxy Catalog (Paturel et al. - 1989, 2003)
6 = [HC-PPL] NGC/IC Accurate Positions List Databases (Corwin - 1996 to 2005)
8 = [SG-NGCO] NGC/IC Observations Databases (Gottlieb - 1998 thru 2005)
9 = [BAS3] Pvt. Letter (Skiff 7/22/92)

Some Notes, Thoughts, Ramblings, and Caveats

Below, are some miscellaneous thoughts that need to be communicated to the user, and these are the ones that didn't fit nicely into any of the explanations of the columns above. They are not in any particular order, but noted in the order that they came to mind.

The user of the HCNGC should be reminded that the primary goal of The NGC/IC Project is to identify all of the missing objects cataloged by Dreyer, and published in the NGC. The secondary goal of the Project has been to document the details behind why the object was missing, and what the research steps consisted of in order to reveal its identity. The third goal of the Project has been to demonstrate the missing object's existence by providing an annotated Digitized Sky Survey image of the newly identified object, and lastly, to provide some ancillary data and information about the object to aid observers in finding it in the night sky, such as position, object type, size, brightness, orientation, etc. This has generally been the ordering of priorities for the project these last thirteen (going on fourteen) years.

The individual researcher's identification of a missing NGC objects should be viewed by the user as most probable. In a lot of cases, the arguments are very compelling, and once revealed, even the most casual observer would agree with the researcher's conclusion. In other cases, it is not so clear cut, with there being multiple candidates for the missing object's identity, with the final choice of identity being made from a number of factors, such as discoverer's telescope aperture, known observing idiosyncrasies, candidate object's brightness, size, and proximity to the documented historical position in the sky, etc. And in still other cases, it is a small stretch of the researcher's imagination, tempered with his/her insight, to conclude the identity of the missing object, because the relevant available information may be quite sketchy, or even contradictory. Through all of this, it should be kept in mind that all of the decisions by the researchers are based upon the historical record, as we know it. In some cases reasonable arguments can be constructed to support an alternate choice for the missing object solution, and we realize that. A good example of this is the many puzzle solution files (historical notes) of Dr. Harold G. Corwin, Jr. located on the Project’s web site. In the spirit of all of this, as better historical information becomes available, the researchers on the Project will consider it and may, in some cases, choose another object as the puzzle solution. Or said another way, this is the best effort of the researchers to date, and today's results may change as time moves forward and additional information becomes available to us.

The Digitized Sky Survey (DSS), both first and second generation, along with NED (NASA's Extragalactic Database), have been found to be an incredible set of tools for this kind of research, which probably helps to explain why this is one of the reasons that the Project has been as successful as we have to date. Our predecessors in this type of activity didn't have it to use as we did. That being said, it should also be understood that for some object types, the DSS may actually be confusing, and since the NGC is a list of objects discovered visually, that is our final method of determination in the case of some object types. Open clusters are a good example. At the eyepiece of a telescope, a particular open cluster may "jump out" at the observer, and be deemed very obvious, as it did to the original discoverer, but when that same cluster is viewed using the DSS, it may not look like an open cluster at all, but just a continuation of the many background stars. This is one of the reasons that the RNGC marked so many of the NGC open clusters as "Nonexistent" - their researchers used only the Palomar Observatory Sky Survey (POSS), and didn't also look at them through the eyepiece of a telescope. So as you look at the DSS images of the NGC objects available on the Project's web site, please keep that in mind, as you will find many examples of this phenomenon.

The ancillary data for each of the objects is just that - ancillary. Its purpose is to provide the user a reasonable set of data points for a particular object, such as size, magnitude, surface brightness, etc. but is not to be construed as a highly accurate source of this type of information, and it is certainly not meant to be used as a gold standard for this type of data. It comes mostly from the professional astronomical catalogs and is only as accurate as the source catalog. That was never the goal of the project, and the ancillary data provided is to aid the user to find and view the object, or to set the viewer's expectations about the object prior to observing the object. To this end, I have calculated new visual/blue magnitudes, as well as visual surface brightnesses for the NGC galaxies based upon the Third Reference Catalogue of Bright Galaxies and the Surface Photometry Catalogue of the ESO-Uppsala galaxies, and these calculated numbers are only as accurate as the source data and the statistical errors contained within them. So I ask the user to use these numbers in that spirit, and not rely too heavily on the absolute accuracy of these numbers. The listed sizes are likewise in the same category. Some of the sizes are from major object catalogs, while some are measured directly by me from DSS images that I enhanced using histogram mapping to accentuate faint outer edges in order to gain extra accuracy. In some cases the size of an object as listed in a major or minor catalog appeared to be in error by a factor of two or three when compared to an image of the same object using the DSS. In those cases the size of the listed object is that from a DSS measurement. Position angles (PA) for galaxies is another parameter of note. There were a lot of cataloged galaxies that had no cataloged PA. In those cases, where it could be determined from the DSS, I actually tried to ascertain the true direction of the North Celestial Pole, and to then measure the PA directly from the image as this is a reasonable methodology, but also be advised that accurately determining the location of the North Celestial Pole for a given 10 arc minute by 10 arc minute image of the sky could only be estimated given that huge amounts of time would be needed to more accurately determine its exact position. In those cases, the PA's I measured are probably no more accurate than say 5° or so, and are most likely to be worse than that. All of this being said, I will still continue to update this section of the HCNGC with the latest and best numbers that I can get, with the goal of providing better data as time goes on. Just be advised that the quest for this data is not very close to the top of the priority list given a multitude of tasks needing attention. That is the nature of the beast.

The data in the HCNGC is the result of long and diligent efforts by the many members of the Project team that submitted it for inclusion into the HCNGC. In a lot of cases, an excellent paper trail exists as to where the data came from, and/or how it was calculated as the sources for it resides in hard copy form in many libraries both at the university level as well as at the professional Observatory level. With the advent of the Internet and the World Wide Web, a research resource was created beyond our wildest dreams, with much of the research now being done on-line using the many amazing search engines available to us. This is an advantage for the electronic researcher, but is also filled with a few potholes that the traditional researcher doesn't worry about. Namely the transient nature of the information on the web. The traditional researcher can always go back to the library from whence they got the information, pull the source of the information from the shelf, and verify it against what they captured the first time they used the source. The electronic researcher, on the other hand, can't always do that. In some cases it is possible if the original web page, or trail of original web pages, still exists, but if it doesn't, then the paper trail is broken and the original source of the information is no longer available. It may appear later, in a different form, on a web page with a different web address, but for now it is gone. I have a whole stack of URLs from doing research over the years, where a large percentage of the web addresses no longer exists. This is due to the inherent transient nature of the Internet, and is beyond the control of the researcher. It again, is the nature of the beast.

The NGC is a collection of non-stellar objects discovered visually. Photography, although invented and disclosed to the public in 1839, hadn't really been used to image a distant star (Alpha Lyrae) until 1850, even though earlier efforts to photographically image the moon and the sun had been successful to varying degrees. Henry Draper, using an 11-inch Alvan Clark refractor designed for photography, took the first photograph of a nebula in September 1880. The first photographs of the Andromeda galaxy (NGC 224) were taken in 1884, and a 7 1/2 hour exposure of the spectrum of the Andromeda galaxy was first taken in 1889 in a quest to try and answer the questions surrounding the possible extragalactic nature of it. It wouldn't be for another couple of decades that the issue would be resolved, but in the interim, more and more astrophotos were taken and the techniques refined. The Index Catalogues (IC I & II) certainly benefited, but alas the new imaging technology was way too late for the original NGC to have benefited, and the only image record is the sketch by the discoverer, if any exists at all. What we are mostly left with is the summary description in the NGC, and the discoverer's description of the object in their individually published notes.

As time moves forward, the contents of the HCNGC will undoubtedly change. When this occurs, and a new list is released on this web site, I will attempt to document the changes that occurred, at the end portion of the list, with a running, quite terse, explanation for each of the previously released versions. Hopefully, this will allow the user to ascertain if they need to upgrade to the latest list, or be satisfied with the previous version they are currently using.

Acknowledgements and Introduction Revision History

04/16/2006	Initial release
04/23/2006	Added narrative and descriptions for two new columns - Historical Notes and Observing Notes
06/24/2006	Added this revision table, and corrected typo in "Sources Used" column explanation, added additional source.
07/12/2006	Added explanations for Uranometria 2000 chart numbers, Herald-Bobroff ASTROATLAS chart numbers, Guide Star Catalog Small Region Numbers, and both the POSS Red and POSS Blue plate numbers.
11/30/2006	Added Acknowledgements section, changed format to .PDF, re-wrote various sections of the introduction for better clarity i.e. Visual Surface Brightness section.
12/10/2006	Modified “Sources Used” column explanation to remove redundant codes and code descriptions.
08/28/2007	Corrected several typos and added additional acknowledgement.