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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**SCENE MONITORING QUALITATIVE DATA REDUCTION**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**4420**
DATE	**OCTOBER 1993**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
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PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	October 1994	
	Reviewed; no changes necessary.	October 1995	
0.1	Modify research scientist's responsibilities.	February 1996	
	Reviewed; no changes necessary.	February 1997	
	Reviewed; no changes necessary.	February 1998	
1.0	Add SVHS video system references.	February 1999	
	Reviewed; no changes necessary.	February 2000	
	Reviewed; no changes necessary.	February 2001	
	-- continued --		

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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	February 2002	
	Reviewed; no changes necessary.	February 2003	
	Reviewed; no changes necessary.	February 2004	
	Reviewed; no changes necessary.	February 2005	
	Reviewed; no changes necessary.	February 2006	
	Reviewed; no changes necessary.	February 2007	
2.0	Added digital image reduction.	April 2007	

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the steps of scene monitoring qualitative data reduction. It serves as a guide to assure quality data from automatic camera and video monitoring stations.

Documenting visibility events and trends is an important aspect of evaluating existing or potential impairment in Class I and other visibility-sensitive areas. Photography is an efficient way to document these events and trends and is an effective method of communicating visibility relationships to decision-makers and to the public. Self-contained, battery-powered, automatic camera visibility monitoring systems or time-lapse video monitoring systems are easily installed and operated at any location. Camera-based monitoring, referred to as scene monitoring, is an effective, economical component of any visibility monitoring program.

Day-to-day variations in visual air quality captured on 35 mm color photographic slides, 8 mm color movie film, SVHS videotape, or high-resolution digital images can be used to:

- Document how vistas appear under various visual air quality, meteorological, and seasonal conditions. Scene characteristics include observer visual range, scene contrast, color, texture, and clarity.
- Record the frequency that various visual air quality conditions occur (e.g., incidence of uniform haze, layered haze, or weather events).
- Provide a quality assurance reference for collocated measurements.
- Determine the visual sensitivity of individual areas or views to variations in ambient air quality.
- Identify areas of potential impairment.
- Estimate the optical properties of the atmosphere under certain conditions.
- Provide quality media for visually presenting program goals, objectives, and results to decision-makers and to the public.
- Provide support data for computer image modeling of potential impairment.
- Support color and human perception research.

Slides, movie film, videotape, or digital images, however, do not provide quantitative information about the cause of visibility impairment. Aerosol and optical properties of the atmosphere must be independently monitored where cause and affect relationships are required.

The following technical instructions (TIs) provide detailed information regarding scene qualitative data reduction:

- TI 4420-5000 *Qualitative Scene Coding and Data Reduction of 35 mm Color Slides*
- TI 4420-5010 *Qualitative 8 mm Time-Lapse Movie Film Review*
- TI 4420-5020 *Qualitative Scene Coding and Data Reduction of High-Resolution Digital Images*
- TI 4420-5050 *Qualitative Time-Lapse Videotape Review for the Healy Clean Coal Project*

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Provide overall coordination of the coding and data reduction procedures.
- Provide technical assistance if required, in the interpretation of slide, film, videotape, or digital images during the qualitative review process.
- Review all slide, film, videotape, or digital image documentation for completeness and accuracy.

2.2 DATA COORDINATOR

The data coordinator shall:

- Perform Stage-1 videotape continuity review.
- Complete an Operational History Log for each videotape.

2.3 DATA TECHNICIAN

The data technician shall:

- Perform 35mm or digital image slide coding.
- Create digital code files.
- Maintain hardcopy records of digital image codes.

2.4 DATA ANALYST

The data analyst shall:

- Oversee film or digital image reduction.
- Review and verify 35 mm slide or digital image codes.
- Perform initial 8 mm film qualitative review.
- Perform Stage-2 qualitative videotape review.
- Prepare qualitative review tables.
- Coordinate with research/project scientist regarding review results.
- Oversee preparation and finalize qualitative review discussions.

2.5 RESEARCH/PROJECT SCIENTIST

The research/project scientist shall:

- Perform secondary 8 mm film qualitative review.
- Perform Stage-3 qualitative videotape review.

- Coordinate with the data analyst regarding review results.
- Oversee all qualitative review stages.
- Prepare initial qualitative review discussions.

3.0 REQUIRED EQUIPMENT AND MATERIALS

3.1 REQUIRED EQUIPMENT AND MATERIALS FOR 35 MM SLIDES

Equipment and materials used to code and validate 35 mm photographic slides include:

- Processed 35 mm slides.
- Slide Condition Code Sheets.
- A light table.
- A hand-held magnifying lens.
- An IBM PC-compatible 386/486 computer system with VGA monitor.
- A computer printer.
- ARS software; SS program, HAZE program.

3.2 REQUIRED EQUIPMENT AND MATERIALS FOR 8 MM TIME-LAPSE FILM

Equipment and materials used to review and validate 8 mm time-lapse movie film include:

- Processed 8 mm time-lapse movie film rolls.
- An 8 mm movie projector.
- Time-Lapse Camera Visibility Monitoring Status/Assessment Sheets.
- Master Logs.
- Supplemental meteorological data (if applicable).

3.3 REQUIRED EQUIPMENT AND MATERIALS FOR SVHS TIME-LAPSE VIDEOTAPE

Equipment and materials used to review and validate SVHS time-lapse videotape include:

- SVHS videotape cassettes.
- An SVHS video cassette player.
- A review monitor.
- Time-Lapse Video Monitoring Status/Assessment Sheets.
- Operational History Logs.
- Supplemental meteorological data, on-site observer comments, etc. (if applicable).

3.4 REQUIRED EQUIPMENT AND MATERIALS FOR DIGITAL IMAGES

Equipment and materials used to code and reduce digital images include:

- .jpg images collected from digital cameras at monitoring sites
- Slide Condition Code Sheet
- Images of monitoring sites annotated with landmarks
- IBM PC-compatible 2.4 gH computer system with 40 gb hard drive and 21" color monitor
- Laserjet printer
- ARS Air Quality Database software

4.0 METHODS

This section includes the following four (4) subsections:

4.1 35 mm Slide Coding and Data Reduction
4.2 8 mm Time-Lapse Film Review
4.3 SVHS Time-Lapse Videotape Review
4.4 High-Resolution Digital Image Coding and Data Reduction

4.1 35 MM SLIDE CODING AND DATA REDUCTION

Not all 35 mm slides undergo the coding process. Slides are only coded if summaries of observed slide conditions are required by the contracting agency. Each photographic slide designated for coding is visually reviewed, chronologically numbered, and assigned a two-digit slide condition code. These qualitative slide condition codes are assigned by the data technician and are verified by the data analyst. The codes document the visual conditions present on each slide, and include observed hazes, plumes, weather conditions or unusable or missing observations.

Coding is normally performed at the end of a season on all slides collected during the season. Each valid slide is viewed on a light table with the naked eye and a hand-held magnifying lens. Codes are recorded directly on the slides and later entered into site-specific digital files. Digital files are used to prepare qualitative summaries of observed haze types and can be searched in a variety of ways to fulfill specific data reports. Slide coding and qualitative summary procedures are detailed in TI 4420-5000, *Qualitative Scene Coding and Data Reduction of 35 mm Color Slides.*

4.2 8 MM TIME-LAPSE FILM REVIEW

Qualitative film review only occurs when a summary of specific information captured on 8 mm time-lapse film is required. For example, this type of qualitative review could be required to support an EIS or other regulatory review process. Film undergoing qualitative film review is closely reviewed for general weather conditions and for the presence/absence of atmospheric anomalies. This review provides a preliminary indication of the types of visual effects observed within the individual vistas.

Original 8 mm film is reviewed primarily for anomaly identification and evaluation. Chronological review tables and comprehensive discussions of any observed anomalies are prepared. It is recommended that original 8 mm film be reviewed. Review of 8 mm film transferred to videotape is also possible, however, loss of image resolution and overall quality is likely to occur in any second-generation film or video product. Film review and procedures are detailed in TI 4420-5010, *Qualitative 8 mm Time-Lapse Movie Film Review.*

4.3 SVHS TIME-LAPSE VIDEOTAPE REVIEW

Qualitative review of time-lapse videotape is generally performed in three stages. Stage-1 is a continuity review and problem resolution; videotapes are reviewed to verify proper camera and system component operation, proper exposure and alignment, and correct operating period. Stage-2 review includes documenting weather conditions and identifying observed visual anomalies or events of interest to the monitoring program. Stage-3 review includes evaluation of these observed anomalies or events. Detailed descriptions of the anomaly are then prepared and include related data, general weather conditions, a discussion of the dynamics of observed anomalies, and a conclusion.

For a detailed description of videotape review procedures, see TI 4305-4050, *Collection, Processing, and Handling of Time-Lapse Videotapes for the Healy Clean Coal Project.*

4.4 HIGH-RESOLUTION DIGITAL IMAGE CODING AND DATA REDUCTION

Not all digital images undergo the coding process. Image coding is performed only if summaries of observed conditions are required by the contracting agency. The project-specific codes are then entered into a database for use in preparing qualitative analysis tables. The codes document the visual conditions present on each image, and include observed hazes, plumes, weather conditions, the presence and magnitude of regional haze, and unusable or missing observations.

Coding is normally performed at the end of a quarter on all images collected during the quarter. Each valid image that is coded is viewed on a color computer monitor with the naked eye. Codes are recorded on hardcopy thumbnail listings, and electronically in the ARS Air Quality DataBase (AQDB). The database is also used to prepare qualitative summaries of observed haze types and can be searched in a variety of ways to fulfill specific data reports. Image coding and qualitative summary procedures are detailed in TI 4420-5020, *Qualitative Scene Coding and Data Reduction of High-Resolution Digital Images.*

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**QUALITATIVE SCENE CODING AND DATA REDUCTION OF HIGH-RESOLUTION DIGITAL IMAGES**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**4420-5020**
DATE	**APRIL 2007**

AUTHORIZATIONS		
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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

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1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes high-resolution digital image coding and qualitative data reduction procedures. This TI is referenced in SOP 4420, *Scene Monitoring Qualitative Data Reduction*, and specifically describes:

- Digital image coding procedures for observed meteorological conditions.
- Digital image data reduction for preparation of qualitative analysis summaries.

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall provide overall coordination of the coding and data reduction procedures.

2.2 DATA ANALYST

The data analyst shall:

- Oversee image coding.
- Review and verify image codes assigned by the data technician.
- Run qualitative summary program software.
- Verify qualitative summary tables.

2.3 DATA TECHNICIAN

The data technician shall:

- Perform image coding.
- Maintain hardcopy records of image codes.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Equipment and materials used in coding and reducing digital images include:

- .jpg images collected from digital cameras at monitoring sites
- Slide Condition Code Sheet
- Images of monitoring sites annotated with landmarks
- IBM PC-compatible 2.4 gH computer system with 40 gb hard drive and 21” color monitor.
- Laserjet printer
- ARS Air Quality Database software

4.0 METHODS

This section includes the following two (2) subsections:

4.1 High-Resolution Digital Image Coding
4.2 High-Resolution Digital Image Data Reduction

4.1 HIGH-RESOLUTION DIGITAL IMAGE CODING

Not all digital images undergo the coding process. Image coding is performed only if summaries of observed conditions are required by the contracting agency. Condition codes qualitatively identify weather conditions, observed hazes or plumes, the presence and magnitude of regional haze, and unusable or missing observations. They are useful for summarizing observed conditions over defined time periods, or in searching for specific observed visibility conditions. Each valid image that is coded is viewed on a color computer monitor with the naked eye. The codes are then entered into a database for use in preparing qualitative analysis tables.

4.1.1 Determining Qualitative Image Codes

Determining qualitative image codes begins with retrieving the desired images from the Air Quality DataBase (AQDB). The image portion of the database is obtained from the AQDB's Data Menu, and selecting **Scene Data Processing.**

RETRIEVE IMAGES

To retrieve images, **View Images** is selected from the Output menu, and a *site/vista* and *start/end dates* are selected for the desired retrieval for coding. Clicking the **Download .jpeg Images** checkbox, then the **Retrieve** button, will copy selected .jpg images to the computer's hard drive for viewing. Figure 4-1 shows the View Images screen.

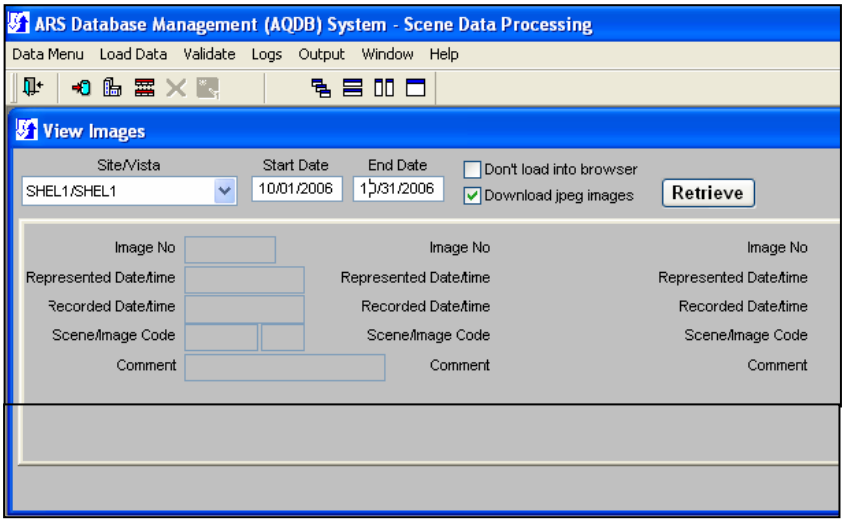

Figure 4-1. AQDB View Images Screen.

RETRIEVE IMAGES (continued)

At the same time that the AQDB View Images screen opens, Internet Explorer software automatically opens. All retrieved images selected in the AQDB will appear in thumbnail view in this software (see Figure 4-2).

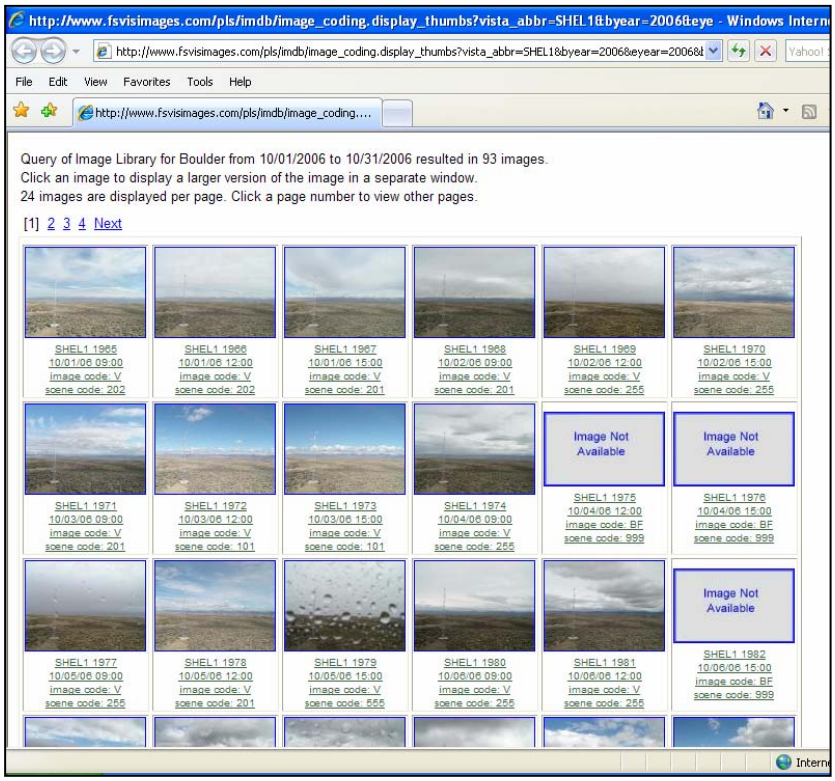

Figure 4-2. Internet Explorer View of Thumbnail Images.

PRINT IMAGE LISTING AND DETERMINE IMAGE CODES

In preparation of coding, a hardcopy of the thumbnail images is printed. Images are enlarged to full screen for viewing during the coding process. Each image can be enlarged by double-clicking on its on-screen thumbnail view.

Qualitative codes are determined using the appropriate image code sheet for the site and program. Figure 4-3 is an example 3-digit code sheet and Figure 4-4 is an example image annotated with landmarks, which is used as a reference in determining the 3rd digit of codes. For example, using these figures, a code of “013” is an image depicting a cloud-free sky, with a ground-based layered haze, and all terrain features from 21km and more distant are obscured by regional haze.

The appropriate codes are then written on each image on the hardcopy thumbnail listing. The listing is then filed along with CDs containing all image .jpg files in a manila envelope in standard file cabinets (see TI 4305-4100, *Collection and Handling of Digital Images*).

IMAGE CONDITION CODE KEY

SKY CONDITIONS	CODE DESCRIPTION
0 No clouds	No clouds visible anywhere in the sky.
1 Scattered clouds < half of sky	Less than one-half of the sky has clouds present.
2 Overcast > half of sky	More than one-half of the sky has clouds present.
3 Haze concealing scene	Atmospheric haze conditions are such that determination of the sky value is impossible.
5 Weather concealing scene	Clouds or precipitation are such that determination of the sky value is impossible.
8 Observation cannot be determined	Observation cannot be determined due to extreme exposure inconsistencies, lens (or window) condensation, misalignment, or view obstructed by a foreign object.
9 No observation	No observation taken.

LAYERED HAZE	CODE DESCRIPTION
0 No layered haze	No layered haze boundary (intensity of coloration edge) is perceptible.
1 Ground-based layered haze only	Only a single-layered haze boundary is perceptible with the haze layer extending to the surface.
2 Elevated layered haze only	An elevated layered haze with two boundaries is perceptible (e.g., horizontal plume).
3 Multiple haze layers	More than a single ground-based or elevated haze layer is perceptible. This can be multiple ground-based layered or a combination of both.
5 Weather concealing scene	Clouds or precipitation are such that determination of the presence of layered hazes is impossible.
9 No observation or cannot be determined	Used with sky condition of 9 or if a layered haze value cannot be determined due to reasons other than weather.

UNIFORM HAZE INTENSITY	CODE DESCRIPTION
1 Slight haze intensity	View of Douglas Peak (49.2 km) impaired.
2 Moderate haze intensity	View of Medina Mountain (33.8 km) impaired.
3 Considerable haze intensity	View of Half Moon Mountain (21 km) and Lost Mountain (25 km) impaired.
5 Weather concealing scene	Clouds or precipitation are such that determination of the presence of layered hazes is impossible.
9 No observation or cannot be determined	Used with sky condition of 9 or if a layered haze value cannot be determined due to reasons other than weather.

Figure 4-3. Example Image Condition Code Key.

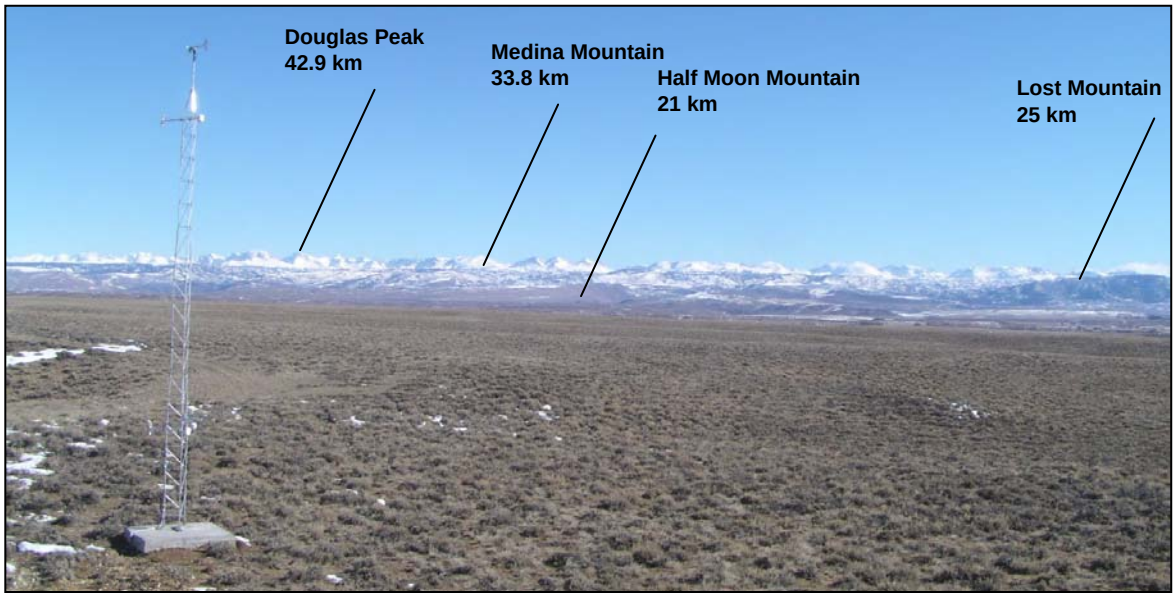

Figure 4-4. Example Image Annotated with Landmarks.

4.1.2 Applying Qualitative Image Codes

APPLY CODES TO IMAGES IN AQDB

Qualitative codes are entered into the Scene Data Processing portion of the AQDB through the Validate menu. The *site and dates* of the images to enter codes for are selected in the Enter Codes for Images screen. Once the Retrieve button is selected, the data entry screen opens with the desired site and period requested (see Figure 4-5).

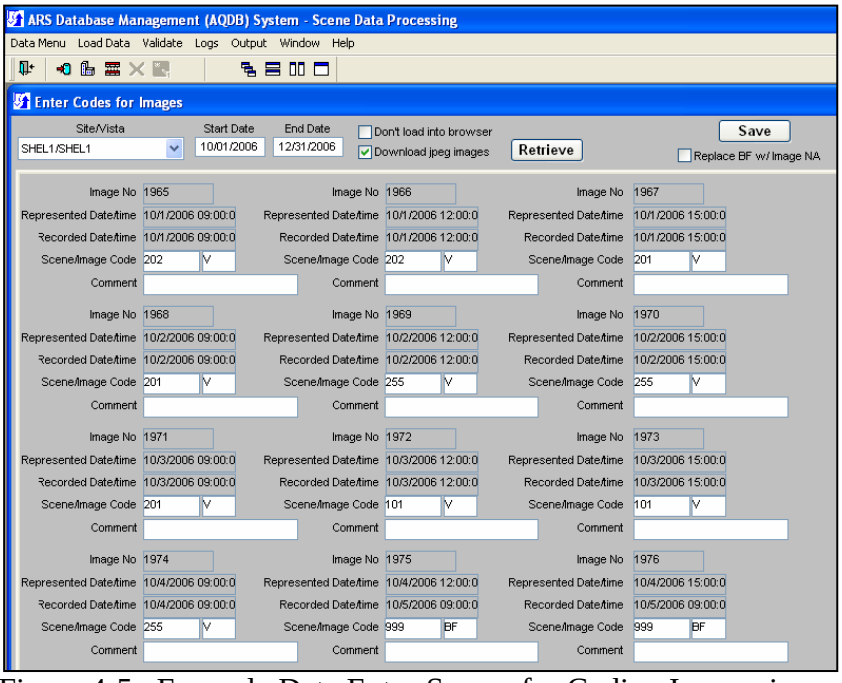

Figure 4-5. Example Data Entry Screen for Coding Images in the AQDB.

APPLY CODES TO IMAGES IN AQDB (continued)

The 3-digit image/scene code is entered for each image, as well as an appropriate 1-character code in the drop-down box next to it. A code of "V" is the default code, meaning "Valid". Other possible codes are BF for blank-filled, DD for duplicate date and time, EX for extraneous, LF for lens flare, etc.

Comments are added in the appropriate field if necessary. **BF when image is not available** is checked if necessary, and finally, the Save button is selected to store all information in the AQDB.

4.2 HIGH-RESOLUTION DIGITAL IMAGE DATA REDUCTION

Qualitative reduction is performed after all images from a calendar quarter are coded. Image code files are named containing the monitoring site abbreviation, and date and time the image was taken.

The naming convention for image files is *SSSSSYYYYMMDDTT*.jpg, where *SSSSS* is the 5-character site abbreviation, and *YYYYMMDDTT* is the year, month, day, and 2-digit abbreviation for the time the image was taken. For example, an image file named BOUL12007010109 is for the Boulder monitoring site, taken January 1, 2007, at 0900.

RUN REPORTS

The AQDB image validation code entries are used to prepare a qualitative summary of observed haze types. Using an IBM PC-compatible computer and the AQDB software, Several report options are available from Output menu. The *report type* and monitoring *site and date* information desired is selected using the fields provided. The Destination tab is used to select output to either a printer or the screen for viewing (see Figure 4-6). The report will be run after selecting the Run Now button.

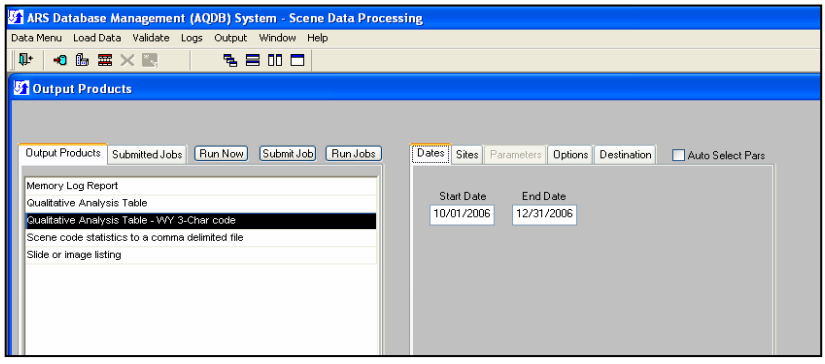

Figure 4-6. AQDB Screen Prompting for Qualitative Report Output Information.

RUN REPORTS (continued)

An example qualitative haze summary table is presented as Table 4-1. When distinct haze layers are visible, they are categorized as ground-based, elevated, or simultaneous ground-based and elevated hazes. All cases where no distinct haze layer occurs are classified as uniform hazes. Cases where the scene is not visible due to haze or weather are also noted.

Table 4-1

Example Qualitative Digital Image Analysis Table

July 1, 2006 through September 30, 2006			Haze Condition Summaries by Number and Percent (%) of Total Observations Collected													
Possible: 276	Collected: 273	Valid: 273	0 Uniform		1 Ground-Based		2 Elevated		3 Multiple		5 Weather Dominates Scene		9 Cannot be Determined		Total Observations Collected	
Month	**Sky Condition Code**		**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
July	Clear	0	14		4		1								19	20.4%
	Scattered Clouds	1	22		4		2								28	30.1%
	Overcast	2	45								1				46	49.5%
	Haze Concealed	3														
	Weather Dominated	5														
	Invalid	8														
July Total			81	87.1%	8	8.6%	3	3.2%			1	1.1%			93	100.0%
August	Clear	0	14		3		3								20	21.7%
	Scattered Clouds	1	22		6										28	30.4%
	Overcast	2	40		2		1				1				44	47.8%
	Haze Concealed	3														
	Weather Dominated	5														
	Invalid	8														
August Total			76	82.6%	11	12.0%	4	4.3%			1	1.1%			92	100.0%
September	Clear	0	13		2		1								19	20.4%
	Scattered Clouds	1	15		2										28	30.1%
	Overcast	2	52		1						2				46	49.5%
	Haze Concealed	3														
	Weather Dominated	5														
	Invalid	8														
September Total			80	90.9%	5	5.7%	1	1.1%			2	2.3%			88	100.0%
Total			237	86.8%	24	8.8%	8	2.9%			4	1.5%			273	100.0%

July 2, 2006 through September 30, 2006			Haze Condition Summaries by Number and Percent (%) of Total Observations Collected													
Possible: 276	Collected: 273	Valid: 273	1 Slight Haze Intensity		2 Moderate Haze Intensity		3 Considerable Haze Intensity				5 Weather Dominates Scene		9 Cannot be Determined		Total Observations Collected	
Month	**Sky Condition Code**		**No.**	**%**	**No.**	**%**	**No.**	**%**			**No.**	**%**	**No.**	**%**	**No.**	**%**
July	Clear	0	11		7		1								19	20.4%
	Scattered Clouds	1	26		2										28	30.1%
	Overcast	2	44		1						1				46	49.5%
	Haze Concealed	3														
	Weather Dominated	5														
	Invalid	8														
July Total			81	87.1%	10	10.8%	1	1.1%			1	1.1%			93	100.0%
August	Clear	0	11		8		1								20	21.7%
	Scattered Clouds	1	27		1										28	30.4%
	Overcast	2	38		5						1				44	47.8%
	Haze Concealed	3														
	Weather Dominated	5														
	Invalid	8														
August Total			76	82.6%	14	15.2%	1	1.1%			1	1.1%			92	100.0%
September	Clear	0	14		2										16	18.2%
	Scattered Clouds	1	17												17	19.3%
	Overcast	2	50		3						2				55	62.5%
	Haze Concealed	3														
	Weather Dominated	5														
	Invalid	8														
September Total			81	92.0%	5	5.7%					2	2.3%			88	100%
Total			238	87.2%	29	10.6%	2	0.7%			4	1.5%			273	100.0%