September 2006

Hydro Plant Risk Assessment Guide

Appendix E10: Compressed Air System Condition Assessment

E10. 1 GENERAL

Compressed air systems are key components at hydroelectric power plants. Compressed air system failure can have a significant economic impact due to the high cost of emergency repairs.

Determining the present condition of a compressed air system is an essential step in analyzing the risk of failure. This appendix provides a process for arriving at a Compressed Air System Condition Index which may be used to develop a business case addressing risk of failure, economic consequences, and other factors.

E10. 2 SCOPE / APPLICATION

The condition assessment methodology outlined in this guide applies to hydroelectric power plant compressed air systems. The condition assessment primarily focuses on the compressors, air dryers, air tanks, control panels, and piping. Air systems covered are ≥ 175 psi (high pressure) for governor air supply and < 175 psi (low pressure) for station service air supply with desiccant or refrigerant air dryers.

This appendix is not intended to define compressed air system maintenance practices or describe in detail inspections, tests, or measurements. Utility-specific maintenance policies and procedures must be consulted for such information.

E10. 3 CONDITION AND DATA QUALITY INDICATORS, AND COMPRESSED AIR SYSTEM CONDITION INDEX

The following indicators are used to separately evaluate the condition of the compressed air system:

- Physical condition
- Operation run time
- Maintenance requirements
- Age of compressed air system

These condition indicators are initially evaluated using Tier 1 inspections, tests, and measurements, which are conducted by utility staff or contractors over the course of time and as a part of routine maintenance activities. Numerical scores are assigned to each condition

indicator, which are then weighted and summed to determine the Compressed Air System Condition Index.

The Compressed Air System Condition Index may indicate the need for immediate corrective actions and/or follow-up testing. To the extent that Tier 1 tests result in immediate corrective actions being taken by plant staff, the condition indicator scores should be adjusted to reflect corrective actions taken and the modified scores used to revise the overall Compressed Air System Condition Index.

An additional stand-alone indicator, the Data Quality Indicator, is used to reflect the quality of the information available for scoring the condition indicators. In some cases, data may be missing, out-of-date, or of questionable integrity. Any of these situations could affect the accuracy of the associated condition indicator scores as well as the validity of the overall Condition Index. Given the potential impact of poor or missing data, the Data Quality Indicator is used as a means of evaluating and recording confidence in the Compressed Air System Condition Index.

Additional information regarding compressed air system condition may be necessary to improve the accuracy and reliability of the Compressed Air System Condition Index. Therefore, in addition to the Tier 1 condition indicators, this appendix describes a "toolbox" of Tier 2 inspections, tests, and measurements that may be applied, depending on the specific issue or problem being addressed. Tier 2 tests are considered non-routine. However, if Tier 2 data is readily available, it may be used to supplement the Tier 1 assessment. Alternately, Tier 2 tests may be deliberately performed to address Tier 1 findings. Results of the Tier 2 analysis may either increase or decrease the score of the Compressed Air System Condition Index. The Data Quality Indicator score may also be revised during the Tier 2 assessment to reflect the availability of additional information or test data.

Note: A severely negative result of ANY inspection, test, or measurement may be adequate in itself to require immediate corrective maintenance actions, regardless of the Compressed Air System Condition Index score.

E10. 4 INSPECTIONS, TESTS, AND MEASUREMENTS

Inspections, tests, and measurements should be conducted and analyzed by staff suitably trained and experienced in compressed air system diagnostics. The more basic tests may be conducted by qualified staff that is competent in these routine procedures. More complex inspections and measurements may require a compressed air system diagnostics expert.

Inspections, tests, and measurements should be performed on a frequency that provides the accurate and current information needed by the assessment.

Details of the inspection, testing, and measurement methods and intervals are described in technical references specific to the electric utility.

E10. 5 SCORING

Condition indicator scoring is somewhat subjective, relying on the experience and opinions of plant staff and experts. Relative terms such as "Results Normal" and "Degradation" refer to results that are compared to industry accepted levels; or to baseline or previously acceptable levels on this equipment; or to equipment of similar design, construction, or age operating in a similar environment

E10. 6 WEIGHTING FACTORS

Weighting factors used in the condition assessment methodology recognize that some condition indicators affect the Compressed Air System Condition Index to a greater or lesser degree than other indicators. These weighting factors were arrived at by consensus among design and maintenance personnel with extensive experience.

E10. 7 MITIGATING FACTORS

Every compressed air system is unique and, therefore, the methodology described in this guide cannot quantify all factors that affect individual condition. It is important that the Compressed Air System Condition Index arrived at be scrutinized by experts. Mitigating factors specific to the utility may affect the final Compressed Air System Condition Index and the final decision on replacement or rehabilitation of the system.

E10. 8 DOCUMENTATION

Substantiating documentation is essential to support findings of the assessment, particularly where a Tier 1 condition indicator score is less than 3 (i.e., less than normal) or where a Tier 2 test results in subtractions to the Compressed Air System Condition Index. Test reports, photographs, O & M records, and other documentation should accompany the Compressed Air System Condition Assessment Summary form.

E10. 9 CONDITION ASSESSMENT METHODOLOGY

The condition assessment methodology consists of analyzing each condition indicator individually to arrive at a condition indicator score. The scores are then weighted and summed to determine the Condition Index.

Reasonable efforts should be made to perform Tier 1 inspections, tests, and measurements. However, when data is unavailable to properly score a condition indicator, it may be assumed that the score is "Good" or numerically equal to some mid-range number such as 2. This strategy must be used judiciously to prevent erroneous results and conclusions. In recognition of the potential impact of poor or missing data, a separate Data Quality Indicator is rated during the Tier 1 assessment as a means of evaluating and recording confidence in the final Compressed Air System Condition Index.

E10.10 TIER 1 – INSPECTIONS, TESTS, AND MEASUREMENTS

Tier 1 tests include those inspections, tests, and measurements that are routinely accomplished as part of normal operation and maintenance, or are readily discernible by examination of existing data. Tier 1 test results are quantified below as condition indicators that are weighted and summed to arrive at a Condition Index. Tier 1 tests may indicate abnormal conditions that can be resolved with standard corrective maintenance solutions. To the extent that Tier 1 tests result in immediate corrective maintenance actions being taken by plant staff, then adjustments to the condition indicators should be reflected and the new results used when computing the overall Tier 1 Condition Index. Tier 1 test results may also indicate the need for additional investigation, categorized as Tier 2 tests.

E10. 11 COMPRESSED AIR SYSTEM CONDITION INDICATORS

Condition Indicator 1 – Physical Condition

Compressed air system problems can often be detected during the course of physical inspections. Problems such as serious air, oil, and water leaks, excessive vibration and abnormal noise while operating, corrosion, warping, belt tension, or failures on control panels may be observed. The known physical condition of the compressed air system is a major indicator of overall system reliability. This indicator relies heavily on maintenance records and past inspection reports.

Qualified personnel should make a determination of scoring that encompasses as many inspection factors as possible under this indicator. Table 1 provides guidance for assigning an appropriate Condition Indicator Score.

Table 1 – Physical Condition Scoring	
Inspection Results	**Physical Condition Indicator Score**
Excellent Condition: Inspection results are normal. • No major air, oil, and water leaks. • No excessive vibration or abnormal noise during operation. • No evidence of heat, corrosion or warping. • No significant condensation or water problems in the compressed air. • No loose or broken fasteners, no cracks in castings or sheet metal shrouding. • Drive belt tensions are correct; belts are in good working condition. • No failures, alarms, abnormal changes in normal operating levels on gauges or indicators and control panels. • Normal lubricating oil level and color. • Lubricating oil is not contaminated. • Air filters are clean. • No excess oil vapours or carbon residue in the air lines. • Pressures are maintained at the expected set point.	3
Good Condition: Inspection results show some deterioration of the criteria mentioned above.	2
Fair Condition: Inspection results show significant deterioration of the criteria mentioned above.	1
Poor Condition: Inspection results show extensive deterioration of the criteria mentioned above.	0

Condition Indicator 2 – Operation Run Time

This condition indicator measures the compressor run time and compares it with expected run time to assess compressor performance and system integrity. It is assumed that an increase in run time indicates a reduction in performance due to worn compressor components (i.e., cylinder wear, ring wear, check valve leakage, or similar wear related effects). The information used to score this indicator should be gathered through normal maintenance activities.

Table 2 – Operation Run Time Scoring	
Amount of Operating Hours	**Operation Run Time Indicator Score**
Compressor operating hours match the air consumption required (100%).	3
Compressor operating hours are somewhat increased but no change of air consumption required and no major air leaks (≥ 100 and < 120%).	2
Compressor operating hours are moderately increased but no change of air consumption required and no major air leaks (≥ 120 and < 150%).	1
Compressor operating hours are significantly increased but no change of air consumption required and no major air leaks (≥ 150%).	0

Condition Indicator 3 – Maintenance Requirements

Assess the level of maintenance required for this equipment. This condition indicator addresses the amount of maintenance that the compressed air system currently requires. It does not address failure to perform maintenance since a lack of maintenance will be reflected in the condition indicator for Physical Condition. The Maintenance Requirements indicator has 3 levels: Minimal, Moderate, and Extensive, as shown in Table 3.

Table 3 – Maintenance Requirements Scoring	
Amount of Required Maintenance	**Maintenance Condition Indicator Score**
Minimal level: A small amount of routine preventive maintenance is required for the compressed air system.	3
Moderate level: Some corrective maintenance is necessary.	2
Extensive level: Frequent repairs, abnormal wear to components, and/or labor-intensive maintenance is required.	1

Condition Indicator 4 – Age of the Compressed Air System

Assess the age of the components and enter the age in Table 4. If design life information is available, use the design life instead of age in Table 4.

Use Table 4 to arrive at an appropriate Compressed Air System Age Indicator Score.

Table 4 – Age Scoring	
Age of the Equipment	**Age Indicator Score**
< 25 years	3
≥ 25 and < 35 years	2
≥ 35 and < 45 years	1
≥ 45 years	0

E10.12 TIER 1 – COMPRESSED AIR SYSTEM CONDITION INDEX CALCULATIONS

Enter the Compressed Air System Condition Indicator Scores from the tables above into the Compressed Air System Condition Assessment Summary form at the end of this document. Multiply each indicator score by its respective Weighting Factor, and sum the Total Scores to arrive at the Tier 1 Compressed Air System Condition Index. The index may be adjusted by the Tier 2 inspections, tests, and measurements described below.

E10.13 TIER 1 – COMPRESSED AIR SYSTEM DATA QUALITY INDICATOR

The Compressed Air System Data Quality Indicator reflects the quality of the inspection, test, and measurement results used to evaluate the compressed air system condition under Tier 1. The more current and complete the results are, the higher the rating for this indicator. The normal testing frequency is defined as the organization's recommended frequency for performing the specific test or inspection.

Qualified personnel should make a subjective determination of scoring that encompasses as many factors as possible under this indicator. Results are analyzed and applied to Table 5 to arrive at an appropriate Compressed Air System Data Quality Indicator Score.

Table 5 – Compressed Air System Data Quality Scoring	
Results	**Compressed Air System Data Quality Indicator Score**
All Tier 1 inspections, tests and measurements were completed within the normal testing frequency (e.g., within the last < 3 years) and the results are reliable.	10
One or more of the Tier 1 inspections, tests and measurements were completed ≥ 1 and < 4 years past the normal testing frequency and the results are reliable.	7
One or more of the Tier 1 inspections, tests and measurements were completed ≥ 4 and < 7 years past the normal testing frequency, or some of the results are not available or are of questionable integrity.	4
One or more of the Tier 1 inspections, tests and measurements were completed ≥ 7 years past the normal frequency, or no results are available or many are of questionable integrity.	0

Enter the Compressed Air System Data Quality Indicator Score from Table 5 into the Compressed Air System Condition Assessment Summary form at the end of this document.

E10. 14 TIER 2 – INSPECTIONS, TESTS, AND MESUREMENTS

If the Compressed Air System Condition Index is fair or poor, Tier 2 evaluations may be warranted. The Tier 2 evaluations are intended to be quantitative performance tests for the compressor and dryer. Tier 2 analysis improves assessment of the status or condition of air system components and should help equipment maintenance personnel assess the need for more extensive corrective maintenance, rehabilitation, or replacement.

After Tier 2 assessments are performed, apply the appropriate adjustment factors as indicated in the tables below. Recalculate the Compressor Condition Index using the Compressor Condition Assessment Summary form at the end of this document. An adjustment to the Data Quality Indicator score may be appropriate if additional or newer information or test results were obtained during the Tier 2 assessment.

Test T2.1: Compressor Performance Testing

Compressor performance testing is intended to assess how well the compressor is working. Measurements usually require special test equipment that will vary depending on the utility or plant.

Test T2.1.1: Compressor Air Flow

Compressor air flow measurements indicate the functionality of the compressor while it is running, and exclude the effects from other system components that will bias the run time data.

Table 6A – Compressor Air Flow Scoring

Measured Results Air Flow Q_{read} Rating Criteria	Adjustment to Compressor Condition Index
Q_{read}[1] > 0.9 Q_{nom}[2]	No change
0.8 $Q_{nom} \leq Q_{read} \leq$ 0.9 Q_{nom}	Subtract 2.0
Q_{read} < 0.8 Q_{nom}	Subtract 6.0

1. Q_{read} is the air flow rate read from a flow meter connected to the discharge port of the compressor. Most compressors are rated in SCFM, cubic feet per minute of standard air, and the data from the meter must be normalized (converted) into SCFM.
2. Q_{nom} is the rated output for the compressor, based either on service records or on manufacturer's output rating.

Test T2.1.2: Compressor Air Temperature

Compressor air temperature measures the effectiveness of the after coolers and/or excessive output temperatures while running.

Table 6B – Compressor Air Temperature Scoring	
Measured Results Air Temperature (last stage) T_{read} Rating Criteria	**Adjustment to Compressor Condition Index**
T_{read}[1] < 1.1 T_{nom}[2]	No change
1.1 $T_{nom} \leq T_{read} \leq$ 1.2 T_{nom}	Subtract 1.0
T_{read} > 1.2 T_{nom}	Subtract 4.0

1. T_{read} is the temperature measurement taken at the discharge from the after cooler. It should be compared to historical data for the same compressor.
2. T_{nom} is the discharge air temperature when the compressor was new or in just-refurbished condition.

Test T2.1.3: Compressor Motor Current

Compressor motor current provides information about the motor condition and input shaft power requirements.

Table 6C – Compressor Motor Current Scoring	
Measured Results Δ I Current Drive Motor between Phases Rating Criteria	**Adjustment to Compressor Motor Condition Index**
Δ I < 3% I_{nom}	No change
3% $I_{nom} \leq$ Δ I ≤ 5% I_{nom}	Subtract 1.0
Δ I > 5% I_{nom}	Subtract 4.0

Test T2.1.4: Compressor Lube Oil Analysis

If Tier 1 testing indicates potential compressor problems that are not easily diagnosed, an oil analysis test program can provide additional information to help identify potential failure modes. As the compressor wears during normal operation, metallic particles up to roughly 15 microns in size will accumulate as a suspension in the oil. The particle size distribution and shape, oxidation, the nature of constituent elements found and especially the rate of change in the particle accumulation rate from one test to the next, are all important indicators of the type of wear occurring.

Oil analysis tests should be performed by taking samples and sending them to a commercial oil analysis laboratory. The laboratory should be consulted for guidance when planning the testing procedure, and the results evaluation procedure should be adjusted to suit the equipment. If time

allows, the analysis is enhanced if you run one sample, operate the machine for a measured amount of time, and then run another sample.

Ferrography (analysis of the size, shape, concentration and size distribution of magnetic particles) should be specified in the oil analysis purchase order. Techniques and guidelines for the Ferrography evaluation process are found in the Wear Particle Atlas prepared for the Advanced Technology Office, Support Equipment Engineering Department, Naval Air Engineering Center, Lakehurst, NJ. Total Acid Number (ASTM D664), Viscosity (ASTM D445/446) and Water (ASTM D4928) should be included. The test report should include an Equipment Condition Rating (ECR) based on a three category classification system, with categories similar to Normal, Marginal, and Abnormal (Critical).

A Normal ECR reflects that all contaminant tests return values and findings that fall within the bounds of normal equipment operating conditions, and the oil properties are within a range of 5% above the upper bound and 5% below the lower bound for new oil properties. A Marginal ECR reflects test results and findings that indicate the presence of wear particles or contaminants that are not found in equipment in good operating condition, or inadequate oil properties, but does not conclusively indicate an in-progress or imminent failure. An Abnormal or Critical ECR reflects a condition that requires immediate attention.

Table 6D – Compressor Lube Oil Analysis Scoring

Oil Condition Rating	Adjustment to Compressor Condition Index
Normal	No Change
Marginal	Subtract 1.0
Critical	Subtract 4.0

Test T2.2: Air Dryer Performance Testing

Air dryer equipment may be desiccant type with or without external heated blowers for purging, or it may be refrigerant type. The function of the dryer is to depress the dew point temperature to a low enough level that moisture will not condense out in the downstream equipment that uses the compressed air. The following tests assess the condition of the dryer by looking at two factors: the dew point temperature depression and thinning of the tank walls due to corrosion and wear.

Test T2.2.1: Air Dryer Dew Point

The dew point temperature depression is the difference between the design dew point of the air entering the dryer and the average dew point of the air leaving the dryer. The loss of dew point depression is measured as the rise in dew point temperature over the life of the dryer expressed as a percentage of the original design dew point temperature depression. Dew point temperature

measurements are computed from temperature, pressure and humidity (hygrometer) measurements.

Table 7A – Air Dryer Dew Point Scoring	
Measured Results Air DewPoint DP $_{read}$ Rating Criteria	**Adjustment to Air Dryer Condition Index**
80 % DewPoint $_{read}$[1] < DP $_{expected}$[2] ≤ 100 % DewPoint $_{read}$	No change
65% DewPoint $_{read}$ ≤ DP $_{expected}$ ≤ 80 % DewPoint $_{read}$	Subtract 2.0
$DP_{expected}$ < 65 % DewPoint $_{read}$	Subtract 4.0

1. $DewPoint_{read}$ is the reading of dew point temperature depression taken during Tier 2 testing.
2. $DP_{expected}$ is the normal dew point temperature depression from the manufacturer's specifications or from historical maintenance records of the equipment.

Test T2.2.2: Air Dryer Wall Thickness

Thinning of the tank walls is measured by non-destructive testing methods, including ultrasonic thickness gauges. Dryer tank wall thickness includes the desiccant tanks and any locations where abrasive wear may have concentrated local effects, such as the outside of the elbows on the tank outlets. Wall thickness measurements should be made for all desiccant tanks at several locations on each tank and piping. Similarly, the air receiver tanks can have loss of wall thickness and should be measured at several locations. The measurement showing the greatest amount of material loss should be used for scoring, both for dryer tanks and for air receiver tanks.

Table 7B – Air Dryer Wall Thickness Scoring	
Measured Results Thickness T_{read} Rating Criteria	**Adjustment to Air Dryer Tower Condition Index**
T_{read}[1] > 60 % T $_{nominal}$[2]	No change
T_{read} ≤ 60 % T $_{nominal}$	Subtract 4.0

1. T_{read} is the wall thickness reading.
2. $T_{nominal}$ is the wall thickness for the dryer tank in new condition.

Test T2.3: Air Receiver Tank Wall Thickness

Table 8 – Air Receiver Tank Wall Thickness Scoring	
Measured Results Air Tank Thickness T_{read} Rating Criteria	**Adjustment to Air Tank Condition Index**
T_{read}[1] > 60 % $T_{nominal}$[2]	No change
$T_{read} \leq 60$ % $T_{nominal}$	Subtract 4.0

1. T_{read} is the current or most recent thickness measurement for the receiver tank.
2. $T_{nominal}$ is the wall thickness of the air receiver tank in new condition.

Test T2.4: Other Specialized Diagnostic Tests

Additional tests may be applied to evaluate specific compressed air system problems. Some of these diagnostic tests may be considered to be of an investigative research nature. When conclusive results from other diagnostic tests are available, engineering judgment or relevant experience may be used to make an appropriate adjustment to the Compressed Air System Condition Index.

E10.15 TIER 2 – COMPRESSED AIR SYSTEM CONDITION INDEX CALCULATIONS

Enter the Tier 2 adjustments from the tables above into the Compressed Air System Condition Assessment Summary form at the end of this guide. Subtract the sum of these adjustments from the Tier 1 Compressed Air System Condition Index to arrive at the Net Compressed Air System Condition Index. Attach supporting documentation. An adjustment to the Data Quality Indicator score may be appropriate if additional information or test results were obtained during the Tier 2 assessment.

E10.16 COMPRESSED AIR SYSTEM CONDITION-BASED ALTERNATIVES

After review by a compressed air system expert, the Compressed Air System Condition Index is suitable for use in a risk-and-economic analysis model. The condition index may be deemed sufficient in itself for decision-making regarding Compressed Air System Condition-Based Alternatives, in which case the Compressed Air System Condition Index may be directly applied to Table 9.

Table 9 – Compressed Air System Condition-Based Alternatives	
Generator Condition Index	**Suggested Course of Action**
≥ 7.0 and ≤ 10 (Good)	Continue O & M without restriction. Repeat condition assessment as needed.
≥ 3.0 and < 7 (Fair)	Continue operation but reevaluate O & M practices. Consider using appropriate Tier 2 tests. Repeat condition assessment process as needed.
≥ 0 and < 3.0 (Poor)	Immediate evaluation including additional Tier 2 testing. Consultation with experts. Adjust O & M as prudent. Begin replacement/rehabilitation process.

COMPRESSED AIR SYSTEM
TIER 1 CONDITION ASSESSMENT SUMMARY

Date: _____ Location: _____

System Working Pressure: _____ psi

Use of Compressed Air System:
- □ Governor Oil Pneumatic Tanks
- □ Generator Braking System
- □ Air Circuit Breakers
- □ Service Air
- □ Turbine Depression
- □ Turbine Air Injection
- □ Other

Compressor: Manufacturer: _____ Number of Stages: _____

Cooling System Type: _____ Motor: _____ HP

Year Installed: _____ Nominal Flow: _____ scfm

Nominal Temperature: _____ Nominal Pressure: _____

(last stage) (last stage)

Air Dryer: Manufacturer: _____ Type of Regeneration: _____

Year Installed: _____

Nominal Wall Thickness – Dryer Tank: _____

Dew Point Expected: _____

Air Receiver: Manufacturer: _____ Year Installed: _____

Safety Valve Model: _____ Valve Adjustment Pressure: _____

Nominal Wall Thickness – Receiver Tank: _____

Tier 1 Compressed Air System Condition Summary *(For instructions on indicator scoring, please refer to condition assessment guide)*				
No.	**Condition Indicator**	**Score** ×	**Weighting Factor** =	**Total Score**
1	Physical Condition *(Score must be 0, 1, 2, or 3)*		0.7	
2	Operation Run Time *(Score must be 0, 1, 2, or 3)*		1.20	
3	Maintenance Requirements *(Score must be 1, 2, or 3)*		1.00	
4	Age *(Score must be 0, 1, 2, or 3)*		0.4	
Tier 1 Compressed Air System Condition Index (Sum of individual Total Scores) *(Condition Index should be between 0 and 10)*				

Tier 1 Data Quality Indicator *(Value must be 0, 4, 7, or 10)*	

Evaluator: _____ Technical Review: _____

Management Review: _____ Copies to: _____

(Attach supporting documentation.)

Compressed Air System Condition-Based Alternatives	
Generator Condition Index	**Suggested Course of Action**
≥ 7.0 and ≤ 10 (Good)	Continue O & M without restriction. Repeat condition assessment as needed.
≥ 3.0 and < 7 (Fair)	Continue operation but reevaluate O & M practices. Consider using appropriate Tier 2 tests. Repeat condition assessment process as needed.
≥ 0 and < 3.0 (Poor)	Immediate evaluation including additional Tier 2 testing. Consultation with experts. Adjust O & M as prudent. Begin replacement/rehabilitation process.

COMPRESSED AIR SYSTEM
TIER 2 CONDITION ASSESSMENT SUMMARY

Date: _____ Location: _____

System Working Pressure: _____ psi

Tier 2 Compressed Air System Condition Summary		
No.	**Tier 2 Test**	**Adjustment to Tier 1 Condition Index**
T2.1.1	Compressor Air Flow	
T2.1.2	Compressor Air Temperature	
T2.1.3	Compressor Motor Current	
T2.1.4	Compressor Lube Oil Analysis	
T2.2.1	Air Dryer Dew Point	
T2.2.2	Air Dryer Wall Thickness	
T2.3	Air Receiver Tank Wall Thickness	
T2.4	Other Specialized Diagnostic Tests	
Tier 2 Adjustments to Compressed Air Condition Index (Sum of individual Adjustments)		

Tier 2 Data Quality Indicator *(Value must be 0, 4, 7, or 10)*	

To calculate the Net Compressed Air System Condition Index *(Value should be between 0 and 10)*, subtract the Tier 2 Adjustments from the Tier 1 Compressed Air System Condition Index:

Tier 1 Compressed Air System Condition Index _____

minus **Tier 2 Compressed Air System Adjustments** _____ = _____

Net Compressed Air System Condition Index

Evaluator: _____ Technical Review: _____

Management Review: _____ Copies to: _____

(Attach supporting documentation.)