

505CC-2 Steam Turbine & Compressor Control Program Worksheet (8701-1356)

(Woodward Publication 26451sup)

505CC-2 Part Number: _____
 505CC-2 Serial Number: _____
 Application: _____
 Date: _____

SYSTEM CONFIGURATION

Control Mode? ITCC ☐ Turbine-Only ☐ Compressor-Only ☐
 System Units? SI ☐ ... SI Pressure Unit (i.e. kPa, kg/cm², atm, Bar)? _____
 Imperial ☐ ... Imperial Pressure Unit (i.e. psi, ftH₂O, Ton/ft, inHg)? _____
 Use Modbus #1? ☐ ...
 Enable Modbus #1 Commands? ☐ Transmission Mode (i.e. ASCII, RTU) _____
 Modbus Device Number? _____ Timeout Delay? 10 sec
 Port #1 Driver Protocol ? _____ Port #1 Baud Rate? _____ bps
 Port #1 Stop Bits? _____ Port #1 Parity? _____
 Use Modbus #2? ☐ ...
 Enable Modbus #2 Commands? ☐ Transmission Mode (i.e. ASCII, RTU) _____
 Modbus Device Number? _____ Timeout Delay? 10 sec
 Port #2 Driver Protocol ? _____ Port #2 Baud Rate? _____ bps
 Port #2 Stop Bits? _____ Port #2 Parity? _____
 Modbus Analog Scaling Cascade Control _____
 Extraction/Admission _____ (1000, 100, 10, 1, 0.1, 0.001, 0.001)
 Inlet/Exhaust _____
 Comp. 1 Flow Input _____ Comp. 2 Flow Input _____
 Comp. 1 Pressure _____ Comp. 2 Pressure _____
 Comp. 1 Calc. Values _____ Comp. 2 Calc. Values _____
 Comp. 1 Temperature _____ Comp. 2 Temperature _____
 Use Local/Remote? ☐ ...
 Enable Contact Inputs? ☐
 Enable Modbus #1? ☐
 Enable Modbus #2? ☐

TURBINE GENERAL CONFIGURATION

Turbine Type? Single Valve ☐
 Extraction Only ☐
 Admission Only ☐
 Extraction/Admission ☐
 Decoupling Type (if two-valve turbine)? Speed - Extr/Adm ☐
 Inlet - Speed ☐
 Exhaust - Speed ☐
 None ☐
 Trip Configuration ... External Trips in Trip Relay? ☐
 Reset Clears Trip Output? ☐
 Valve Labels ... HP/LP ☐ V1/V2 ☐
 Turbine Units ... If SI is selected Turbine Power Units (i.e. kW, MW)? _____
 Steam Flow Units (i.e. kg/hr, t/hr)? _____
 If Imperial is selected Turbine Power Units (i.e. kW, MW, HP, lb-ft/s)? _____
 Steam Flow Units (i.e. lb/hr, klb/hr)? _____

TURBINE START CONFIGURATION

Select Start Mode ... Manual ☐
 Automatic ☐
 Semi-Automatic ☐
 Rate to MinGov? _____ rpm/s
 Select Start Initial Speed ...
 Minimum Governor (Rated) ☐ ...
 Minimum Controllable Speed? _____ rpm
 Single Idle (Idle/Rated) ☐ ...
 Idle Speed? _____ rpm
 Auto Start Sequence ☐ ...
 Low Idle Speed _____ rpm High Idle Speed _____ rpm
 Cold Start (> ? hours) _____ hours Hot Start (< ? Hours) _____ hours
 Low Idle Delay (Cold) _____ mins Low Idle Delay (Hot) _____ mins
 Ramp to High Idle (Cold) _____ rpm/s Ramp to High Idle (Hot) _____ rpm/s

High Idle Delay (Cold)		mins	High Idle Delay (Hot)	_____mins
Ramp to Rated (Cold)		rpm/s	Ramp to Rated (Hot)	_____rpm/s
Auto Halt at Idles?	☐			

SPEED CONTROL CONFIGURATION

Speed Sensor Settings ...

Teeth Seen by MPU? _____ Gear Ratio? 1: _____ Failed Speed Level _____ rpm
 Use MPU 2? ☐ Use MPU Override Timer? ☐ Override Time? _____ sec

Select Dynamics Settings ...

Single Only ☐ Dual – Above MinGov ☐
 Dual – Contact Input ☐ Dual – Decoupling ☐
 Proportional Gain 1 _____ % Integral Gain 1 _____ rps Speed Derivative Ratio 1 _____ %
 Proportional Gain 2 _____ % Integral Gain 2 _____ rps Speed Derivative Ratio 2 _____ %

Speed Setpoint Values ...

Minimum Governor Speed _____ rpm Maximum Governor Speed _____ rpm
 Default Rate _____ rpm/s Fast Rate _____ rpm/s Fast Rate Delay _____ sec
 Controlled Shutdown ...
 Rate to Idle _____ rpm/s Rate to Min _____ rpm/s Cooldown Time _____ min
 Overspeed Test Limit _____ rpm Overspeed Trip Setpoint _____ rpm
 Use Critical Speeds? ☐
 Critical Speed Rate _____ rpm/s Critical 1 Max _____ rpm Critical 1 Min _____ rpm
 Use Critical Band 2? ☐ Critical 2 Max _____ rpm Critical 2 Min _____ rpm
 Speed Reference Bias ... Amount _____ % Delay _____ sec
 Use Remote Speed Setpoint? ☐ Remote Rate _____ rpm/s
 Valve Position to Speed Decoupling ...
 Feed-Forward Enable? ☐ Feed-Forward Amount _____ % Feed-Forward Delay _____ sec

CASCADE CONTROL CONFIGURATION

Use Cascade Control? ☐ ... Use Cascade Tracking? ☐ Invert Cascade Input? ☐
 Cascade Units (Pressure or Flow)? _____
 Minimum Cascade Setpoint _____ eng units Maximum Cascade Setpoint _____ eng units
 Cascade Default Rate _____ eng units/s Cascade Setpoint Initial Value _____ eng units
 Cascade Fast Rate Delay _____ sec Cascade Setpoint Fast Rate _____ eng units/s
 Cascade Droop _____ %
 Use Cascade Minimum Speed? ☐ ... Minimum Speed Setting _____ rpm
 Select Cascade Source ...
 External – 4-20mA Input ☐
 Internal – Compressor Train Suction Pressure ☐
 Internal – Compressor Train Discharge Pressure ☐
 Internal – Compressor 1 Mass/Normal Flow ☐
 Internal – Compressor 1 Suction Volume Flow ☐
 Internal – Compressor 2 Mass/Normal Flow ☐
 Internal – Compressor 2 Suction Volume Flow ☐
 Proportional Gain _____ % Integral Gain _____ rps Speed Derivative Ratio _____ %
 Cascade Control Deadband _____ %
 Use Remote Cascade Setpoint? ☐ ... Remote Rate _____ eng units/s
 Remote Min. Setpoint _____ eng units Remote Max. Setpoint _____ eng units

TURBINE VALVE LIMITER CONFIGURATION

HP/V1 Limiter Rate _____ %/s HP/V1 Minimum Limit _____ % HP/V1 Maximum Limit _____ %
 LP/V2 Limiter Rate _____ %/s LP/V2 Minimum Limit _____ % LP/V2 Maximum Limit _____ %

MANUAL PRESSURE DEMAND CONFIGURATION**(For 2-Valve Turbines)**

Use Manual Flow Control? ☐ ... Use Flow Setpoint Tracking? ☐
 Minimum Flow Setpoint _____ % Maximum Flow Setpoint _____ %
 Flow Default Rate _____ %/s Flow Setpoint Initial Value N/A %
 Flow Fast Rate Delay _____ sec Flow Setpoint Fast Rate _____ %/s
 Use Remote Flow Setpoint? ☐ ... Remote Flow Rate _____ %/s
 Remote Min. Setpoint _____ % Remote Max. Setpoint _____ %

TURBINE EXTRACTION/ADMISSION CONTROL CONFIGURATION**(For 2-Valve Turbines)**

E/A Units (Pressure or Flow)? _____ Use E/A Tracking? ☐ Invert E/A Input? ☐
 If E/A Input fails? ... Goto Max LP/V2 ☐ Trip ☐
 Goto Min LP/V2 ☐ Manual Demand ☐ Back to Auto After Reset? ☐
 Minimum E/A Setpoint _____ eng units Maximum E/A Setpoint _____ eng units
 E/A Default Rate _____ eng units/s E/A Setpoint Initial Value _____ eng units
 E/A Fast Rate Delay _____ sec E/A Setpoint Fast Rate _____ eng units/s
 E/A Droop _____ %
 Proportional Gain _____ % Integral Gain _____ rps Speed Derivative Ratio _____ %

E/A Control Deadband _____ %
Use Remote E/A Setpoint? ☐ ...
Remote Min. Setpoint _____ eng units

Remote E/A Rate _____ eng units/s
Remote Max. Setpoint _____ eng units

TURBINE STEAM MAP CONFIGURATION**(For 2-Valve Turbines)**Use Automatic Enable? ☐ Max Power Limiter _____eng units Max HP/V1 Flow Limiter _____eng units**Extraction Turbine ...**

Point A	Max Power @ Min Extr	_____eng units	Max HP/V1 Flow @ Min Extr	_____eng units
Point B	Min Power @ Max Extr	_____eng units	Min HP/V1 Flow @ Max Extr	_____eng units
Point C	Min Power @ Min Extr	_____eng units	Min HP/V1 Flow @ Min Extr	_____eng units

Admission Turbine ...

Point A	Max Power @ Max Adm	_____eng units	Max HP/V1 Flow @ Max Adm	_____eng units
	Max Adm Flow	_____eng units		
Point B	Min Power @ Min Adm	_____eng units	Min HP/V1 Flow @ Min Adm	_____eng units
Point C	Max Power @ Min Adm	_____eng units	Max HP/V1 Flow @ Min Adm	_____eng units

Extraction/Admission Turbine ...

Point A	Max Power @ 0 E/A	_____eng units	Max HP/V1 Flow @ 0 E/A	_____eng units
	Max Adm Flow	_____eng units		
Point B	Min Power @ Max Extr	_____eng units	Min HP/V1 Flow @ Max Extr	_____eng units
Point C	Min Power @ 0 E/A	_____eng units	Min HP/V1 Flow @ 0 E/A	_____eng units

INLET/EXHAUST CONTROL CONFIGURATION**(For 2-Valve Turbines using Inlet or Exhaust Decoupling)**

I/E Units (Pressure or Flow)? _____	Use I/E Tracking? ☐	Invert I/E Input? ☐
	Use Automatic Decoupling Enable? ☐	

If I/E Input fails? ...

Disable Extr Adm	☐	
Goto Manual Coupled Mode	☐	Back to Auto After Reset? ☐
Goto Manual Decoupled Mode	☐	

Minimum I/E Setpoint	_____eng units	Maximum I/E Setpoint	_____eng units
I/E Default Rate	_____eng units/s	I/E Setpoint Initial Value	_____eng units
I/E Fast Rate Delay	_____sec	I/E Setpoint Fast Rate	_____eng units/s
I/E Droop	_____%	Manual Rate	_____%/s
Proportional Gain	_____%	Integral Gain	_____rps
I/E Control Deadband	_____%	Speed Derivative Ratio	_____%
Use Remote I/E Setpoint? ☐ ...		Remote I/E Rate	_____eng units/s
Remote Min. Setpoint	_____eng units	Remote Max. Setpoint	_____eng units

TURBINE ANALOG I/O CONFIGURATION

Analog Input Fail Level Low	_____mA	Analog Input Fail Level High	_____mA
Analog Input 1 Function			
Analog Input 1 4mA Value	_____eng units	Analog Input 1 20mA Value	_____eng units
Analog Input 2 Function ...			
Analog Input 2 4mA Value	_____eng units	Analog Input 2 20mA Value	_____eng units
Analog Input 3 Function ...			
Analog Input 3 4mA Value	_____eng units	Analog Input 3 20mA Value	_____eng units
Analog Input 4 Function			
Analog Input 4 4mA Value	_____eng units	Analog Input 4 20mA Value	_____eng units
Analog Input 5 Function ...			
Analog Input 5 4mA Value	_____eng units	Analog Input 5 20mA Value	_____eng units
Analog Input 6 Function (Steam Pressure)...			
Analog Input 6 4mA Value	_____eng units	Analog Input 6 20mA Value	_____eng units
Analog Readout 1 Function			
Analog Readout 1 4mA Value	_____eng units	Analog Readout 1 20mA Value	_____eng units
Analog Readout 2 Function ...			
Analog Readout 2 4mA Value	_____eng units	Analog Readout 2 20mA Value	_____eng units
Select HP/V1 Actuator Driver Type ...	4-20mA ☐	or 0-190mA ☐	
Invert Driver Output ?	☐	Shutdown on Actuator Driver Failure?	☐
Dither Amount	_____mA	Maximum (100%) Current	_____mA
Minimum (0%) Current	_____mA		
Select LP/V2 Actuator Driver Type ...	4-20mA ☐	or 0-190mA ☐	
Invert Driver Output ?	☐	Shutdown on Actuator Driver Failure?	☐
Dither Amount	_____mA	Maximum (100%) Current	_____mA
Minimum (0%) Current	_____mA		

TURBINE DISCRETE I/O CONFIGURATION

Discrete Input 1 Function	<u>Emergency Shutdown</u>	Discrete Input 7 Function	_____
Discrete Input 2 Function	<u>System Reset</u>	Discrete Input 8 Function	_____
Discrete Input 3 Function	<u>Raise Speed Setpoint</u>	Discrete Input 9 Function	_____
Discrete Input 4 Function	<u>Lower Speed Setpoint</u>	Discrete Input 10 Function	_____
Discrete Input 5 Function	_____	Discrete Input 11 Function	_____
Discrete Input 6 Function	_____	Discrete Input 12 Function	_____
Discrete Output 1 Function			
Discrete Output 1 Function	<u>Unit Shutdown</u>		
Discrete Output 2 Function			
Discrete Output 2 Function	<u>Unit Alarm</u>		
Use Discrete Output #3?	☐ ...	Discrete Output 3 Function	_____
Use as a Level Switch?	☐ On Level	_____eng units Off Level	_____eng units
Use Discrete Output #4?	☐ ...	Discrete Output 4 Function	_____
Use as a Level Switch?	☐ On Level	_____eng units Off Level	_____eng units
Use Discrete Output #5?	☐ ...	Discrete Output 5 Function	_____
Use as a Level Switch?	☐ On Level	_____eng units Off Level	_____eng units
Use Discrete Output #6?	☐ ...	Discrete Output 6 Function	_____
Use as a Level Switch?	☐ On Level	_____eng units Off Level	_____eng units

COMPRESSOR GENERAL CONFIGURATION

Absolute Pressure Inputs? ☐ If not, use what atmospheric pressure offset for gauge inputs? _____ eng units
(i.e. 14.696 psia)

Air Compressor without Suction Pressure Transmitter? ☐

Select Algorithm ... Standard ☐

Universal ☐

Enable Temperature Inputs for Display? ☐

Select Stage Layout ... Single ☐

Dual w/ 1 FE ☐

Dual w/ 2 FE ☐

Dual w/ SideStream ☐

If Dual w/ SideStream, what direction?

Admission ☐

Extraction ☐

Gas Composition? Constant ☐

Variable ☐

Select Section 1 Flow Element Location ...

Suction ☐

Discharge ☐

SideStream ☐

None ☐

Select Section 2 Flow Element Location ...

Suction ☐

Discharge ☐

SideStream ☐

None ☐

Select Section 1 Temperature Sensor Location ...

Suction ☐

Discharge ☐

Suction & Discharge ☐

SideStream ☐

SideStream & Discharge ☐

Select Section 2 Temperature Sensor Location ...

Suction ☐

Discharge ☐

Suction & Discharge ☐

SideStream ☐

SideStream & Discharge ☐

Number of Recycle/Blowoff Valves (1 or 2)? _____

Select Valve Layout (for Dual w/ 1 FE configurations and 2 Valves)...

Individual Recycles

Common Suction

Common Discharge

☐

☐

☐

COMPRESSOR STAGE 1 OPEN LOOP CONFIGURATION

Select Surge Detection Routines (all that apply) ... Setpoint ...

Flow Derivative ☐

_____%/s

Suction Pressure Derivative ☐

____eng units/s

Discharge Pressure Derivative ☐

____eng units/s

Speed Derivative ☐

____rpm/s

Minimum Flow ☐

____eng units

Surge Limit Line Crossed ☐

Loop Period? _____ sec

Enable SCL Shift on Surge Detection? ☐

Shift Amount _____%

Surge Recovery Routine Enabled? ☐ ...

... in Full Manual? ☐

Valve Step Amount _____%

Minimum Valve Position _____%

BOOST Routine Enabled? ☐ ...

Valve Step Amount _____%

BOOST Margin _____%

Surge Minimum Position (SMP) Enabled? ☐ ...

SMP Amount _____%

Pre-Pack Enabled? ☐ ...

Valve Step Amount _____%

Valve Sequencing ...

Shutdown Position _____%

Zero-Speed Position _____%

Start Position _____%

Purge Position _____%

Zero Speed Threshold _____rpm

Shutdown Delay Time _____sec

Decoupling Routines Enabled? ☐ ...

Decoupling Output Limit _____%

S_PV Range _____%

Fast Speed Delay Time _____sec

Fast Speed Amount _____%/rpm

Slow Speed Delay Time _____sec

Slow Speed Amount _____m³/hr/rpm

Input 1 Delay Time _____sec

Input 1 Amount _____%

Input 2 Delay Time _____sec

Input 2 Amount _____%

Another Stage Delay Time _____sec

Another Stage Amount _____%

COMPRESSOR STAGE 1 CLOSED LOOP CONFIGURATION

Select Online Detection Routines (all that apply) ...

Speed ☐

Suction Pressure ☐

Discharge Pressure ☐

Flow ☐

Auxiliary Discrete Input ☐

Anti-Surge PID Control ...

Setpoints ...

_____ rpm

_____ eng units

_____ eng units

_____ eng units

Rate PID Control Enabled? ☐ ...

Proportional Gain _____ %

Integral Gain _____ rpt/s

Speed Derivative Ratio _____ %

Enable Auto Gain Compensation? ☐

Proportional Gain _____ %

Integral Gain _____ rpt/s

Speed Derivative Ratio _____ %

Setpoint _____ % of max rate

Suction Pressure Override Enabled? ☐ ...

Enable Auto Gain Compensation? ☐

Proportional Gain _____ %

Integral Gain _____ rpt/s

Speed Derivative Ratio _____ %

Setpoint _____ eng units

Discharge Pressure Override Enabled? ☐ ...

Enable Auto Gain Compensation? ☐

Proportional Gain _____ %

Integral Gain _____ rpt/s

Speed Derivative Ratio _____ %

Setpoint _____ eng units

Auto Gain Compensation (if enabled, or if Slow Speed Decoupling is enabled) ...

Anti-Surge Valve Coefficient _____ (Cv)

Normal Value _____ m³/hr

COMPRESSOR STAGE 1 I/O CONFIGURATION

Input Filter Delay Times ...

Flow Input _____ sec

Pressure Inputs _____ sec

Temperature Inputs _____ sec

Fail to Manual on all Input Failures? ☐ ...

If not, enable Last Good Value on which Input Failures?

Enter Default Values for all Inputs.

Suction Pressure ☐ _____ eng units

Discharge Pressure ☐ _____ eng units

Flow Pressure ☐ _____ eng units

Suction Temperature ☐ _____ eng units

Discharge Temperature ☐ _____ eng units

Flow Temperature ☐ _____ eng units

Gas Properties ...

Suction Compressibility _____

Discharge Compressibility _____

Online Compressibility Calculation? ☐ ...

Compressor Polytropic Efficiency _____ %

Specific Heat Ratio (average value) _____

If so, enter Critical Temperature _____ eng units

Critical Pressure _____ eng units

Flow Input ...

Flow input compensated (calibrated in mass or normal flow)? ☐If not, is the input differential pressure (square-root extraction necessary)? ☐

Flow display units (also calibration units if "compensated" – Mass or Normal/Std)? _____

Base Control Margin? _____ %

Number of Intercooled Sections? _____

Anti-Surge Valve Configuration ...

Invert Output (Fail Open Valve)? ☐

Valve Decay Rate (Auto) _____ %/s

Enable Valve Freeze Function ☐ ...

Enable HSS Auxiliary Input 1 ☐ ...

Enable HSS Auxiliary Input 2 ☐ ...

Enable Valve Overstroke ☐ ...

Freeze Delay Time _____ sec

Input 1 Filter Delay Time _____ sec

Input 2 Filter Delay Time _____ sec

Overstroke Amount Open _____ %

Overstroke Amount Closed _____ %

Manual Control Configuration ...

Remote Manual Valve Positioning? ☐

Manual Valve Ramp Rate _____ %/s

Sensor Fail Additional Amount _____ %

Alarm only on High Scale Flow Failure? ☐

Shutdown Positioning while in Manual? ☐

COMPRESSOR STAGE 1 MAP CONFIGURATION

Enter the flow and polytropic head data pairs, in ascending order, for five points along the predicted Surge Limit Line:

If the **Standard Algorithm** is selected ...

X ₁	_____	Am ³ /hr	Y ₁	_____	N·m/kg
X ₂	_____	Am ³ /hr	Y ₂	_____	N·m/kg
X ₃	_____	Am ³ /hr	Y ₃	_____	N·m/kg
X ₄	_____	Am ³ /hr	Y ₄	_____	N·m/kg
X ₅	_____	Am ³ /hr	Y ₅	_____	N·m/kg

If the performance map is expressed with a different representation of head, or in Imperial units instead of SI, the CCT Standard Mapper Tool can reconfigure the map given the following data. The supported Imperial flow unit is Acfm. In addition to polytropic head (N·m/kg, kg·m/kg, ft·lb/lb), absolute discharge pressure (kPa, Atm, kg/cm², bar, psi) and pressure ratio may also be converted.

X ₁	_____	eng units	Y ₁	_____	eng units
X ₂	_____	eng units	Y ₂	_____	eng units
X ₃	_____	eng units	Y ₃	_____	eng units
X ₄	_____	eng units	Y ₄	_____	eng units
X ₅	_____	eng units	Y ₅	_____	eng units

The following data should be taken from the manufacturer's compressor performance map and data sheet.

Rated Suction Pressure (Absolute)	_____	eng units
Rated Suction Temperature	_____	eng units
Gas Molecular Weight	_____	
Rated Suction Specific Heat Ratio (k)	_____	(Cp/Cv)
Rated Suction Compressibility (Z)	_____	
Rated Discharge Specific Heat Ratio (k)	_____	(Cp/Cv)
Rated Discharge Compressibility (Z)	_____	
Rated Compressor Polytropic Efficiency	_____	%

To calculate the flow coefficient for a differential flow element (Compressor Stage 1 I/O Configuration), enter the following data from the flow element calculation sheet. For best results, the process conditions used for the flow element calculation should be similar to those of the rated compressor operation.

Flow Element Beta Ratio (β)	_____
Flow Element Discharge Coefficient (C)	_____
Flow Element Gas Expansion Factor (Y)	_____
Flow Element Bore (Throat) Diameter (d)	_____ mm

If the **Universal Algorithm** is selected, the CCT Universal Mapper Tool must be used to convert the manufacturer's map into pressure ratio and "corrected" suction flow ...

X ₁	_____	Am ³ /hr	Y ₁	_____
X ₂	_____	Am ³ /hr	Y ₂	_____
X ₃	_____	Am ³ /hr	Y ₃	_____
X ₄	_____	Am ³ /hr	Y ₄	_____
X ₅	_____	Am ³ /hr	Y ₅	_____

The Universal Mapper Tool will also calculate a "corrected flow constant and polytropic exponent.

"Corrected" Flow Constant	_____ m ³ /hr	Polytropic Exponent	_____
---------------------------	--------------------------	---------------------	-------

Enter the five data pairs from the given map (as with the Standard Mapper Tool described above), and enter the following from the compressor performance map and data sheet.

Select the flow element type ...

Concentric, Square-edged		Diamond-II Annubar (Size 15,16)	☐
Orifice w/ Flange Taps	☐	Diamond-II Annubar (Size 25,26)	☐
Flowtube (Badger Lo-Loss, etc)	☐	Diamond-II Annubar (Size 35,36)	☐
V-Cone	☐	Diamond-II Annubar (Size 45,46)	☐
Venturi	☐	Rosemount 485 Annubar (Size 1)	☐
Other	☐	Rosemount 485 Annubar (Size 2)	☐
		Rosemount 485 Annubar (Size 3)	☐

Select the flow element location ... Suction ☐ Discharge ☐

Enter the following data from the flow element calculation sheet. For best results, the process conditions used for the flow element calculation should be similar to those of the rated compressor operation.

Pipe Internal Diameter (D) (at the FE)	_____	eng units
Flow Element Beta Ratio (β)	_____	} Depending upon flow element type
Flow Element Discharge Coefficient (C)	_____	
Flow Element Gas Expansion Factor (Y)	_____	

The following data should be taken from the manufacturer's compressor performance map and data sheet.

Gas Molecular Weight	_____
Rated Suction Pressure	_____ eng units
Rated Suction Temperature	_____ eng units
Rated Suction Specific Heat Ratio (k)	_____ (Cp/Cv)
Rated Suction Compressibility (Z)	_____
Rated Discharge Pressure	_____ eng units
Rated Discharge Temperature	_____ eng units

Rated Discharge Specific Heat Ratio (k) _____ (Cp/Cv)
Rated Discharge Compressibility (Z) _____
Rated Compressor Polytropic Efficiency _____ %

COMPRESSOR STAGE 2 OPEN LOOP CONFIGURATION

Select Surge Detection Routines (all that apply) ...		Setpoint ...	
Flow Derivative	☐	_____	%/s
Suction Pressure Derivative	☐	_____	eng units/s
Discharge Pressure Derivative	☐	_____	eng units/s
Speed Derivative	☐	_____	rpm/s
Minimum Flow	☐	_____	eng units
Surge Limit Line Crossed	☐		
Loop Period?		_____	sec
Enable SCL Shift on Surge Detection?	☐	Shift Amount	_____ %
Surge Recovery Routine Enabled?	☐ ...	... in Full Manual?	☐
		Valve Step Amount	_____ %
		Minimum Valve Position	_____ %
BOOST Routine Enabled?	☐ ...	Valve Step Amount	_____ %
		BOOST Margin	_____ %
Surge Minimum Position (SMP) Enabled?	☐ ...	SMP Amount	_____ %
Pre-Pack Enabled?	☐ ...	Valve Step Amount	_____ %
Valve Sequencing ...		Shutdown Position	_____ %
		Zero-Speed Position	_____ %
		Start Position	_____ %
		Purge Position	_____ %
		Zero Speed Threshold	_____ rpm
		Shutdown Delay Time	_____ sec
Decoupling Routines Enabled?	☐ ...		
Decoupling Output Limit	_____ %	S_PV Range	_____ %
Fast Speed Delay Time	_____ sec	Fast Speed Amount	_____ %/rpm
Slow Speed Delay Time	_____ sec	Slow Speed Amount	_____ m ³ /hr/rpm
Input 1 Delay Time	_____ sec	Input 1 Amount	_____ %
Input 2 Delay Time	_____ sec	Input 2 Amount	_____ %
Another Stage Delay Time	_____ sec	Another Stage Amount	_____ %

COMPRESSOR STAGE 2 CLOSED LOOP CONFIGURATION

Select Online Detection Routines (all that apply) ...		Setpoints ...	
Speed	☐	_____	rpm
Suction Pressure	☐	_____	eng units
Discharge Pressure	☐	_____	eng units
Flow	☐	_____	eng units
Auxiliary Discrete Input	☐		
Anti-Surge PID Control ...		Proportional Gain	_____ %
		Integral Gain	_____ rpt/s
		Speed Derivative Ratio	_____ %
		Enable Auto Gain Compensation?	☐
Rate PID Control Enabled?	☐ ...	Proportional Gain	_____ %
		Integral Gain	_____ rpt/s
		Speed Derivative Ratio	_____ %
		Setpoint	_____ % of max rate
		Enable Auto Gain Compensation?	☐
Suction Pressure Override Enabled?	☐ ...	Proportional Gain	_____ %
		Integral Gain	_____ rpt/s
		Speed Derivative Ratio	_____ %
		Setpoint	_____ eng units
		Enable Auto Gain Compensation?	☐
Discharge Pressure Override Enabled?	☐ ...	Proportional Gain	_____ %
		Integral Gain	_____ rpt/s
		Speed Derivative Ratio	_____ %
		Setpoint	_____ eng units
		Enable Auto Gain Compensation?	☐
Auto Gain Compensation (if enabled, or if Slow Speed Decoupling is enabled) ...			
Anti-Surge Valve Coefficient	_____ (Cv)		
Normal Value	_____ m ³ /hr		

COMPRESSOR STAGE 2 I/O CONFIGURATION

Input Filter Delay Times ...

Flow Input _____sec

Pressure Inputs _____sec

Temperature Inputs _____sec

Fail to Manual on all Input Failures? ☐ ...

If not, enable Last Good Value on which Input Failures?

Enter Default Values for all Inputs.

Suction Pressure ☐ _____eng unitsDischarge Pressure ☐ _____eng unitsFlow Pressure ☐ _____eng unitsSuction Temperature ☐ _____eng unitsDischarge Temperature ☐ _____eng unitsFlow Temperature ☐ _____eng units

Gas Properties ...

Suction Compressibility _____

Compressor Polytropic Efficiency _____%

Discharge Compressibility _____

Specific Heat Ratio (average value) _____

Online Compressibility Calculation? ☐ ...

If so, enter Critical Temperature _____eng units

Critical Pressure _____eng units

Flow Input ...

Flow input compensated (calibrated in mass or normal flow)? ☐If not, is the input differential pressure (square-root extraction necessary)? ☐

Flow display units (also calibration units if "compensated" – Mass or Normal/Std)? _____

Base Control Margin? _____%

Number of Intercooled Sections? _____

Anti-Surge Valve Configuration ...

Invert Output (Fail Open Valve)? ☐

Valve Decay Rate (Auto) _____%/s

Enable Valve Freeze Function ☐ ...

Freeze Delay Time _____sec

Enable HSS Auxiliary Input 1 ☐ ...

Input 1 Filter Delay Time _____sec

Enable HSS Auxiliary Input 2 ☐ ...

Input 2 Filter Delay Time _____sec

Enable Valve Overstroke ☐ ...

Overstroke Amount Open _____%

Overstroke Amount Closed _____%

Manual Control Configuration ...

Remote Manual Valve Positioning? ☐

Manual Valve Ramp Rate _____%/s

Sensor Fail Additional Amount _____%

Alarm only on High Scale Flow Failure? ☐Shutdown Positioning while in Manual? ☐

COMPRESSOR STAGE 2 MAP CONFIGURATION

Enter the flow and polytropic head data pairs, in ascending order, for five points along the predicted Surge Limit Line:

If the **Standard Algorithm** is selected ...

X ₁	_____	Am ³ /hr	Y ₁	_____	N·m/kg
X ₂	_____	Am ³ /hr	Y ₂	_____	N·m/kg
X ₃	_____	Am ³ /hr	Y ₃	_____	N·m/kg
X ₄	_____	Am ³ /hr	Y ₄	_____	N·m/kg
X ₅	_____	Am ³ /hr	Y ₅	_____	N·m/kg

If the performance map is expressed with a different representation of head, or in Imperial units instead of SI, the CCT Standard Mapper Tool can reconfigure the map given the following data. The supported Imperial flow unit is Acfm. In addition to polytropic head (N·m/kg, kg·m/kg, ft·lb/lb), absolute discharge pressure (kPa, Atm, kg/cm², bar, psi) and pressure ratio may also be converted.

X ₁	_____	eng units	Y ₁	_____	eng units
X ₂	_____	eng units	Y ₂	_____	eng units
X ₃	_____	eng units	Y ₃	_____	eng units
X ₄	_____	eng units	Y ₄	_____	eng units
X ₅	_____	eng units	Y ₅	_____	eng units

The following data should be taken from the manufacturer's compressor performance map and data sheet.

Rated Suction Pressure (Absolute)	_____	eng units
Rated Suction Temperature	_____	eng units
Gas Molecular Weight	_____	
Rated Suction Specific Heat Ratio (k)	_____	(Cp/Cv)
Rated Suction Compressibility (Z)	_____	
Rated Discharge Specific Heat Ratio (k)	_____	(Cp/Cv)
Rated Discharge Compressibility (Z)	_____	
Rated Compressor Polytropic Efficiency	_____	%

To calculate the flow coefficient for a differential flow element (Compressor Stage 1 I/O Configuration), enter the following data from the flow element calculation sheet. For best results, the process conditions used for the flow element calculation should be similar to those of the rated compressor operation.

Flow Element Beta Ratio (β)	_____
Flow Element Discharge Coefficient (C)	_____
Flow Element Gas Expansion Factor (Y)	_____
Flow Element Bore (Throat) Diameter (d)	_____ mm

If the **Universal Algorithm** is selected, the CCT Universal Mapper Tool must be used to convert the manufacturer's map into pressure ratio and "corrected" suction flow ...

X ₁	_____	Am ³ /hr	Y ₁	_____
X ₂	_____	Am ³ /hr	Y ₂	_____
X ₃	_____	Am ³ /hr	Y ₃	_____
X ₄	_____	Am ³ /hr	Y ₄	_____
X ₅	_____	Am ³ /hr	Y ₅	_____

The Universal Mapper Tool will also calculate a "corrected flow constant and polytropic exponent.

"Corrected" Flow Constant	_____ m ³ /hr	Polytropic Exponent	_____
---------------------------	--------------------------	---------------------	-------

Enter the five data pairs from the given map (as with the Standard Mapper Tool described above), and enter the following from the compressor performance map and data sheet.

Select the flow element type ...

Concentric, Square-edged		Diamond-II Annubar (Size 15,16)	☐
Orifice w/ Flange Taps	☐	Diamond-II Annubar (Size 25,26)	☐
Flowtube (Badger Lo-Loss, etc)	☐	Diamond-II Annubar (Size 35,36)	☐
V-Cone	☐	Diamond-II Annubar (Size 45,46)	☐
Venturi	☐	Rosemount 485 Annubar (Size 1)	☐
Other	☐	Rosemount 485 Annubar (Size 2)	☐
		Rosemount 485 Annubar (Size 3)	☐

Select the flow element location ... Suction ☐ Discharge ☐

Enter the following data from the flow element calculation sheet. For best results, the process conditions used for the flow element calculation should be similar to those of the rated compressor operation.

Pipe Internal Diameter (D) (at the FE)	_____	eng units
Flow Element Beta Ratio (β)	_____	} Depending upon flow element type
Flow Element Discharge Coefficient (C)	_____	
Flow Element Gas Expansion Factor (Y)	_____	

The following data should be taken from the manufacturer's compressor performance map and data sheet.

Gas Molecular Weight	_____
Rated Suction Pressure	_____ eng units
Rated Suction Temperature	_____ eng units
Rated Suction Specific Heat Ratio (k)	_____ (Cp/Cv)
Rated Suction Compressibility (Z)	_____
Rated Discharge Pressure	_____ eng units
Rated Discharge Temperature	_____ eng units

Rated Discharge Specific Heat Ratio (k) _____(Cp/Cv)
Rated Discharge Compressibility (Z) _____
Rated Compressor Polytropic Efficiency _____%

COMPRESSOR ANALOG I/O CONFIGURATION

Analog Input Fail Level Low _____mA

Analog Input 7 Function ...
 Analog Input 7 4mA Value _____eng units

Analog Input 8 Function ...
 Analog Input 8 4mA Value _____kPa

Analog Input 9 Function ...
 Analog Input 9 4mA Value _____kPa

Analog Input 10 Function ...
 Analog Input 10 4mA Value _____°C

Analog Input 11 Function ...
 Analog Input 11 4mA Value _____°C

Analog Input 12 Function ...
 Analog Input 12 4mA Value _____eng units

Analog Input 13 Function ...
 Analog Input 13 4mA Value _____kPa

Analog Input 14 Function ...
 Analog Input 14 4mA Value _____kPa

Analog Input 15 Function ...
 Analog Input 15 4mA Value _____°C

Analog Input 16 Function ...
 Analog Input 16 4mA Value _____°C

Analog Input 17 Function ...
 Analog Input 17 4mA Value _____eng units

Analog Input 18 Function ...
 Analog Input 18 4mA Value _____eng units

Analog Input 19 Function ...
 Analog Input 19 4mA Value _____eng units

Analog Input 20 Function ...
 Analog Input 20 4mA Value _____eng units

Analog Input 21 Function ...
 Analog Input 21 4mA Value _____eng units

Analog Readout 3 Function
 Analog Readout 3 4mA Value _____eng units

Analog Readout 4 Function ...
 Analog Readout 4 4mA Value _____eng units

Analog Readout 5 Function ...
 Minimum (Closed) Position 0.0 %
 Dither Amount _____%

Analog Readout 6 Function ...
 Minimum (Closed) Position 0.0 %
 Dither Amount _____%

Analog Input Fail Level High _____mA

Compressor 1 Flow
 Analog Input 7 20mA Value _____eng units

Compressor 1 Suction Pressure
 Analog Input 8 20mA Value _____kPa

Compressor 1 Discharge Pressure
 Analog Input 9 20mA Value _____kPa

Compressor 1 Suction Temperature
 Analog Input 10 20mA Value _____°C

Compressor 1 Discharge Temperature
 Analog Input 11 20mA Value _____°C

Compressor 2 Flow
 Analog Input 12 20mA Value _____eng units

Compressor 2 Suction Pressure
 Analog Input 13 20mA Value _____kPa

Compressor 2 Discharge Pressure
 Analog Input 14 20mA Value _____kPa

Compressor 2 Suction Temperature
 Analog Input 15 20mA Value _____°C

Compressor 2 Discharge Temperature
 Analog Input 16 20mA Value _____°C

 Analog Input 17 20mA Value _____eng units

 Analog Input 18 20mA Value _____eng units

 Analog Input 19 20mA Value _____eng units

 Analog Input 20 20mA Value _____eng units

 Analog Input 21 20mA Value _____eng units

 Analog Readout 3 20mA Value _____eng units

 Analog Readout 4 20mA Value _____eng units

Compressor 1 Anti-Surge Valve Output
 Maximum (Open) Position 100.0 %

Compressor 2 Anti-Surge Valve Output
 Maximum (Open) Position 100.0 %

COMPRESSOR DISCRETE I/O CONFIGURATION

Discrete Input 13 Function Open Stage 1 As Valve

Discrete Input 14 Function Close Stage 1 As Valve

Discrete Input 15 Function Open Stage 2 As Valve

Discrete Input 16 Function Close Stage 2 As Valve

Discrete Input 17 Function _____

Discrete Input 18 Function _____

Use Discrete Output #7? ☐ ...

Use Discrete Output #8? ☐ ...

Use Discrete Output #9? ☐ ...

Use Discrete Output #10? ☐ ...

Use Discrete Output #11? ☐ ...

Use Discrete Output #12? ☐ ...

Discrete Input 19 Function _____

Discrete Input 20 Function _____

Discrete Input 21 Function _____

Discrete Input 22 Function _____

Discrete Input 23 Function _____

Discrete Input 24 Function _____

Discrete Output 7 Function _____

Discrete Output 8 Function _____

Discrete Output 9 Function _____

Discrete Output 10 Function _____

Discrete Output 11 Function _____

Discrete Output 12 Function _____