

505CC-2 Steam Turbine & Compressor Control Program Worksheet (8701-1114)

(Woodward Publication 26240sup Revision A)

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

SYSTEM CONFIGURATION

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? _____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? _____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
 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 _____ engunits Maximum Cascade Setpoint _____ engunits
 Cascade Default Rate _____ engunits/s Cascade Setpoint Initial Value _____ engunits
 Cascade Fast Rate Delay _____ sec Cascade Setpoint Fast Rate _____ engunits/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 _____ engunits/s
 Remote Min. Setpoint _____ engunits Remote Max. Setpoint _____ engunits

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 ☐
 Minimum E/A Setpoint _____ engunits Maximum E/A Setpoint _____ engunits
 E/A Default Rate _____ engunits/s E/A Setpoint Initial Value _____ engunits
 E/A Fast Rate Delay _____ sec E/A Setpoint Fast Rate _____ engunits/s
 E/A Droop _____ %
 Proportional Gain _____ % Integral Gain _____ rps Speed Derivative Ratio _____ %
 E/A Control Deadband _____ %

Use Remote E/A Setpoint?

☐ ...

Remote Min. Setpoint

_____engunits

Remote E/A Rate

_____engunits/s

Remote Max. Setpoint

_____engunits

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

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

Admission Turbine ...

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

Extraction/Admission Turbine ...

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

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?	☐
If I/E Input fails? ...		Disable ExtrAdm	☐		
		Goto Manual Coupled Mode	☐		
		Goto Manual Decoupled Mode	☐		
Minimum I/E Setpoint	_____engunits	Maximum I/E Setpoint	_____engunits		
I/E Default Rate	_____engunits/s	I/E Setpoint Initial Value	_____engunits		
I/E Fast Rate Delay	_____sec	I/E Setpoint Fast Rate	_____engunits/s		
I/E Droop	_____%	Manual Rate	_____%/s		
Proportional Gain	_____%	Integral Gain	_____rps	Speed Derivative Ratio	_____%
I/E Control Deadband	_____%				
Use Remote I/E Setpoint?	☐ ...	Remote I/E Rate	_____engunits/s		
Remote Min. Setpoint	_____engunits	Remote Max. Setpoint	_____engunits		

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	_____engunits	Analog Input 1 20mA Value	_____engunits
Analog Input 2 Function ...			
Analog Input 2 4mA Value	_____engunits	Analog Input 2 20mA Value	_____engunits
Analog Input 3 Function ...			
Analog Input 3 4mA Value	_____engunits	Analog Input 3 20mA Value	_____engunits
Analog Input 4 Function			
Analog Input 4 4mA Value	_____engunits	Analog Input 4 20mA Value	_____engunits
Analog Input 5 Function ...			
Analog Input 5 4mA Value	_____engunits	Analog Input 5 20mA Value	_____engunits
Analog Input 6 Function (Steam Pressure)...			
Analog Input 6 4mA Value	_____engunits	Analog Input 6 20mA Value	_____engunits
Analog Readout 1 Function			
Analog Readout 1 4mA Value	_____engunits	Analog Readout 1 20mA Value	_____engunits
Analog Readout 2 Function ...			
Analog Readout 2 4mA Value	_____engunits	Analog Readout 2 20mA Value	_____engunits
Analog Readout 3 Function ...			
Analog Readout 3 4mA Value	_____engunits	Analog Readout 3 20mA Value	_____engunits
Analog Readout 4 Function ...			
Analog Readout 4 4mA Value	_____engunits	Analog Readout 4 20mA Value	_____engunits
Select HP/V1 Actuator Driver Type ...	4-20mA ☐	or	0-190mA ☐
Invert Driver Output ?	☐	Shutdown on Actuator Driver Failure? ☐	
Dither Amount	_____mA		
Minimum (0%) Current	_____mA	Maximum (100%) Current	_____mA
Select LP/V2 Actuator Driver Type ...	4-20mA ☐	or	0-190mA ☐
Invert Driver Output ?	☐	Shutdown on Actuator Driver Failure? ☐	
Dither Amount	_____mA		
Minimum (0%) Current	_____mA	Maximum (100%) 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	<u>Unit Shutdown</u>		
Discrete Output 2 Function	<u>Unit Alarm</u>		
Use Discrete Output #3? ☐ ...		Discrete Output 3 Function	_____
Use as a Level Switch? ☐	On Level	_____engunits	Off Level _____engunits
Use Discrete Output #4? ☐ ...		Discrete Output 4 Function	_____
Use as a Level Switch? ☐	On Level	_____engunits	Off Level _____engunits
Use Discrete Output #5? ☐ ...		Discrete Output 5 Function	_____
Use as a Level Switch? ☐	On Level	_____engunits	Off Level _____engunits
Use Discrete Output #6? ☐ ...		Discrete Output 6 Function	_____
Use as a Level Switch? ☐	On Level	_____engunits	Off Level _____engunits

COMPRESSOR GENERAL CONFIGURATION

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

Air Compressor without Suction Pressure Transmitter? ☐

Select Algorithm ... Standard ☐
Universal ☐

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 ☐ _____ engunits/s

Discharge Pressure Derivative ☐ _____ engunits/s

Speed Derivative ☐ _____ rpm/s

Minimum Flow ☐ _____ engunits

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 _____ %

Fast Speed Delay Time _____ sec

Slow Speed Delay Time _____ sec

Input 1 Delay Time _____ sec

Input 2 Delay Time _____ sec

Another Stage Delay Time _____ sec

S_PV Range _____ %

Fast Speed Amount _____ %/rpm

Slow Speed Amount _____ m³/hr/rpm

Input 1 Amount _____ %

Input 2 Amount _____ %

Another Stage Amount _____ %

COMPRESSOR STAGE 1 CLOSED LOOP CONFIGURATION

Select Online Detection Routines (all that apply) ...	Setpoints ...
Speed ☐	_____ rpm
Suction Pressure ☐	_____ engunits
Discharge Pressure ☐	_____ engunits
Flow ☐	_____ engunits
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 _____ engunits
	Enable Auto Gain Compensation? ☐
Discharge Pressure Override Enabled? ☐ ...	Proportional Gain _____ %
	Integral Gain _____ rpt/s
	Speed Derivative Ratio _____ %
	Setpoint _____ engunits
	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 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 ☐	_____ engunits
Discharge Pressure ☐	_____ engunits
Flow Pressure ☐	_____ engunits
Suction Temperature ☐	_____ engunits
Discharge Temperature ☐	_____ engunits
Flow Temperature ☐	_____ engunits
Gas Properties ...	
Suction Compressibility _____	Compressor Polytropic Efficiency _____ %
Discharge Compressibility _____	Specific Heat Ratio (average value) _____
Online Compressibility Calculation? ☐ ...	If so, enter Critical Temperature _____ engunits
	Critical Pressure _____ engunits
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 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	_____	engunits	Y ₁	_____	engunits
X ₂	_____	engunits	Y ₂	_____	engunits
X ₃	_____	engunits	Y ₃	_____	engunits
X ₄	_____	engunits	Y ₄	_____	engunits
X ₅	_____	engunits	Y ₅	_____	engunits

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

Rated Suction Pressure (Absolute)	_____	engunits
Rated Suction Temperature	_____	engunits
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	_____
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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)	_____	engunits
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	_____ engunits
Rated Suction Temperature	_____ engunits
Rated Suction Specific Heat Ratio (k)	_____ (Cp/Cv)
Rated Suction Compressibility (Z)	_____
Rated Discharge Pressure	_____ engunits
Rated Discharge Temperature	_____ engunits

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	☐	_____ engunits/s	
Discharge Pressure Derivative	☐	_____ engunits/s	
Speed Derivative	☐	_____ rpm/s	
Minimum Flow	☐	_____ engunits	
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 ...	_____ rpm
Speed	☐	_____ engunits	
Suction Pressure	☐	_____ engunits	
Discharge Pressure	☐	_____ engunits	
Flow	☐	_____ engunits	
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	_____ engunits
		Enable Auto Gain Compensation?	☐
Discharge Pressure Override Enabled?	☐	Proportional Gain	_____ %
		Integral Gain	_____ rpt/s
		Speed Derivative Ratio	_____ %
		Setpoint	_____ engunits
		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 ☐ _____engunitsDischarge Pressure ☐ _____engunitsFlow Pressure ☐ _____engunitsSuction Temperature ☐ _____engunitsDischarge Temperature ☐ _____engunitsFlow Temperature ☐ _____engunits

Gas Properties ...

Suction Compressibility _____ Compressor Polytropic Efficiency _____%

Discharge Compressibility _____ Specific Heat Ratio (average value) _____

Online Compressibility Calculation? ☐ ... If so, enter Critical Temperature _____engunits

Critical Pressure _____engunits

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	_____	engunits	Y ₁	_____	engunits
X ₂	_____	engunits	Y ₂	_____	engunits
X ₃	_____	engunits	Y ₃	_____	engunits
X ₄	_____	engunits	Y ₄	_____	engunits
X ₅	_____	engunits	Y ₅	_____	engunits

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

Rated Suction Pressure (Absolute)	_____	engunits
Rated Suction Temperature	_____	engunits
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	_____
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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)	_____	engunits
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	_____ engunits
Rated Suction Temperature	_____ engunits
Rated Suction Specific Heat Ratio (k)	_____ (Cp/Cv)
Rated Suction Compressibility (Z)	_____
Rated Discharge Pressure	_____ engunits
Rated Discharge Temperature	_____ engunits

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 Fail Level High	_____ mA
Analog Input 7 Function ...		<u>Compressor 1 Flow</u>	
Analog Input 7 4mA Value	_____ engunits	Analog Input 7 20mA Value	_____ engunits
Analog Input 8 Function ...		<u>Compressor 1 Suction Pressure</u>	
Analog Input 8 4mA Value	_____ kPa	Analog Input 8 20mA Value	_____ kPa
Analog Input 9 Function ...		<u>Compressor 1 Discharge Pressure</u>	
Analog Input 9 4mA Value	_____ kPa	Analog Input 9 20mA Value	_____ kPa
Analog Input 10 Function ...		<u>Compressor 1 Suction Temperature</u>	
Analog Input 10 4mA Value	_____ °C	Analog Input 10 20mA Value	_____ °C
Analog Input 11 Function ...		<u>Compressor 1 Discharge Temperature</u>	
Analog Input 11 4mA Value	_____ °C	Analog Input 11 20mA Value	_____ °C
Analog Input 12 Function ...		<u>Compressor 2 Flow</u>	
Analog Input 12 4mA Value	_____ engunits	Analog Input 12 20mA Value	_____ engunits
Analog Input 13 Function ...		<u>Compressor 2 Suction Pressure</u>	
Analog Input 13 4mA Value	_____ kPa	Analog Input 13 20mA Value	_____ kPa
Analog Input 14 Function ...		<u>Compressor 2 Discharge Pressure</u>	
Analog Input 14 4mA Value	_____ kPa	Analog Input 14 20mA Value	_____ kPa
Analog Input 15 Function ...		<u>Compressor 2 Suction Temperature</u>	
Analog Input 15 4mA Value	_____ °C	Analog Input 15 20mA Value	_____ °C
Analog Input 16 Function ...		<u>Compressor 2 Discharge Temperature</u>	
Analog Input 16 4mA Value	_____ °C	Analog Input 16 20mA Value	_____ °C
Analog Input 17 Function ...			
Analog Input 17 4mA Value	_____ engunits	Analog Input 17 20mA Value	_____ engunits
Analog Input 18 Function ...			
Analog Input 18 4mA Value	_____ engunits	Analog Input 18 20mA Value	_____ engunits
Analog Input 19 Function ...			
Analog Input 19 4mA Value	_____ engunits	Analog Input 19 20mA Value	_____ engunits
Analog Input 20 Function ...			
Analog Input 20 4mA Value	_____ engunits	Analog Input 20 20mA Value	_____ engunits
Analog Input 21 Function ...			
Analog Input 21 4mA Value	_____ engunits	Analog Input 21 20mA Value	_____ engunits
Analog Readout 5 Function			
Analog Readout 5 4mA Value	_____ engunits	Analog Readout 5 20mA Value	_____ engunits
Analog Readout 6 Function ...			
Analog Readout 6 4mA Value	_____ engunits	Analog Readout 6 20mA Value	_____ engunits
Analog Readout 7 Function ...		<u>Compressor 1 Anti-Surge Valve Output</u>	
Minimum (Closed) Position	<u>0.0</u> %	Maximum (Open) Position	<u>100.0</u> %
Dither Amount	_____ %		
Analog Readout 8 Function ...		<u>Compressor 2 Anti-Surge Valve Output</u>	
Minimum (Closed) Position	<u>0.0</u> %	Maximum (Open) Position	<u>100.0</u> %
Dither Amount	_____ %		

COMPRESSOR DISCRETE I/O CONFIGURATION

Discrete Input 13 Function	<u>Open Stage 1 As Valve</u>	Discrete Input 19 Function	_____
Discrete Input 14 Function	<u>Close Stage 1 As Valve</u>	Discrete Input 20 Function	_____
Discrete Input 15 Function	<u>Open Stage 2 As Valve</u>	Discrete Input 21 Function	_____
Discrete Input 16 Function	<u>Close Stage 2 As Valve</u>	Discrete Input 22 Function	_____
Discrete Input 17 Function	_____	Discrete Input 23 Function	_____
Discrete Input 18 Function	_____	Discrete Input 24 Function	_____
Use Discrete Output #7?	☐ ...	Discrete Output 7 Function	_____
Use Discrete Output #8?	☐ ...	Discrete Output 8 Function	_____
Use Discrete Output #9?	☐ ...	Discrete Output 9 Function	_____
Use Discrete Output #10?	☐ ...	Discrete Output 10 Function	_____
Use Discrete Output #11?	☐ ...	Discrete Output 11 Function	_____
Use Discrete Output #12?	☐ ...	Discrete Output 12 Function	_____