Health-Ready Components and Systems

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SAE ITC®
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Collaborative Innovation.
Trusted Implementation.

PRESENTATIONS AT UPCOMING CONFERENCES

- HM-1 Committee April 2-4, 2019 (Charlotte, NC) hosted by Collins Aerospace
- SAE World Congress Experience WCX April 9-11, 2019 (Detroit, MI)
- AMC/AEEC (Avionics Maintenance Committee/Airlines Electronic Engineering Committee) April 29-May 2, 2019 (Prague, Czech Republic)
- IEEE International Conference on PHM June 17-19, 2019 (Burlingame, CA)
- EFB Users Forum June 25-27, 2019 (Chicago, IL)
- PHM Society Asia-Pacific Conference July 23-25, 2019 (Beijing, China)
- PHM Society Annual Conference September 21-26, 2019 (Scottsdale, AZ)

WEBSITE DEVELOPMENT

- Website is the main landing page, with tabs for:
  - About HRCS
  - Charter (draft)
  - News
  - Events
  - Presentations
  - Testimonials
  - Feedback
  - Anticipated future tabs for members and sponsors

- https://www.sae-itc.com/health-ready-components-and-systems-hrcs-strategy-group

HRCS DATABASE

SAE JA6268™ CERTIFICATION PROCESS

Background Info

SAE HRCS HEALTH-READY COMPONENTS REGISTRY

Registry WILL NOT contain any proprietary information (only Stage 1 information will be included regardless of the Stage completed.)

IVHM CAPABILITY *(NOTE: VEHICLE LEVEL)* (SOURCE: SAE JA6268™)

Illustrating industry evolution in use of diagnosis & prognosis for vehicle maintenance

SAE Level	Vehicle Health Capability	Narrative Description	Participation in Repair Actions	Key Data Resources	Availability of Logged &/or Real-Time Data	Use of Supporting Models	IVHM System Characteristics
Manual Diagnosis & Repair Process performed by Technician							
0	Limited On-Vehicle Warning Indicators	Service actions for scheduled maintenance or when Operator notices problems or is alerted by indicator lights or simple gages.	**Operator/Driver & Service Tech**	On-Vehicle Measurements & Observation	N/A	Paper-based Manuals	Only Manual Diagnostic Tools & No Condition-Based Services
1	Enhanced Diagnostics Using Scan Tools	Service techs gain added diagnostic insight using automated scanners to extract vehicle operating parameters & diagnostic codes.	Operator/Driver & Service Tech	**On-Vehicle & Service Bay/ Depot Tools**	Logged Diagnostic Codes & Parameters available to Service Tech	Paper-based Manuals	On-Board Diagnostics Available
2	Telematics Providing Real-Time Data	Service techs gain real-time vehicle data via remote monitoring of vehicle to more completely capture issues.	Operator/Driver, Service Tech & Remote Support Center Advisor	On-Vehicle, Service Bay / Depot & Cloud Data	**Telematic Data Available to Service Tech with Diagnostics Info**	Paper-based Manuals	On-Board & Remote Data Available
Diagnosis & Repair Augmented by Prognosis & Predictive Analytics							
3	Component Level Proactive Alerts	Operator and service techs are provided with component health status (R/Y/G) before problem occurs . Limited condition-based maintenance.	Operator/Driver, Service Tech & Cloud-Based Services	On-Vehicle, Service Bay & Cloud Data	Telematic Data Available to Service Tech with Diagnostics Info	**Addition of Component-Level Health Models**	Component-Level Health Predictions
4	Integrated Vehicle Health Mgmt.	Operator and service techs are provided with system or vehicle level health indicators before problems occur with remaining useful life estimated. Condition-based maintenance.	Operator/Driver, Service Tech & Cloud-Based Services	On-Vehicle, Service Bay & Cloud Data	Telematic Data Available to Service Tech with Diagnostics Info	Addition of Vehicle-Level Health Models	**Vehicle-Level Health Management**
5	Self-Adaptive Health Mgmt.	Self-adaptive control and optimization to extend vehicle operation and enhance safety in presence of potential or actual failures.	Operator/Driver, Service Tech & Cloud-Based Services	On-Vehicle, Service Bay & Cloud Data	Telematic Data Available to Service Tech with Diagnostics Info	Addition of Vehicle-Level Health Models	**IVHM Capability Integrated into Vehicle Controls**

ISO FUNCTIONAL REFERENCE MODEL *(INDIVIDUAL COMPONENT LEVEL)**

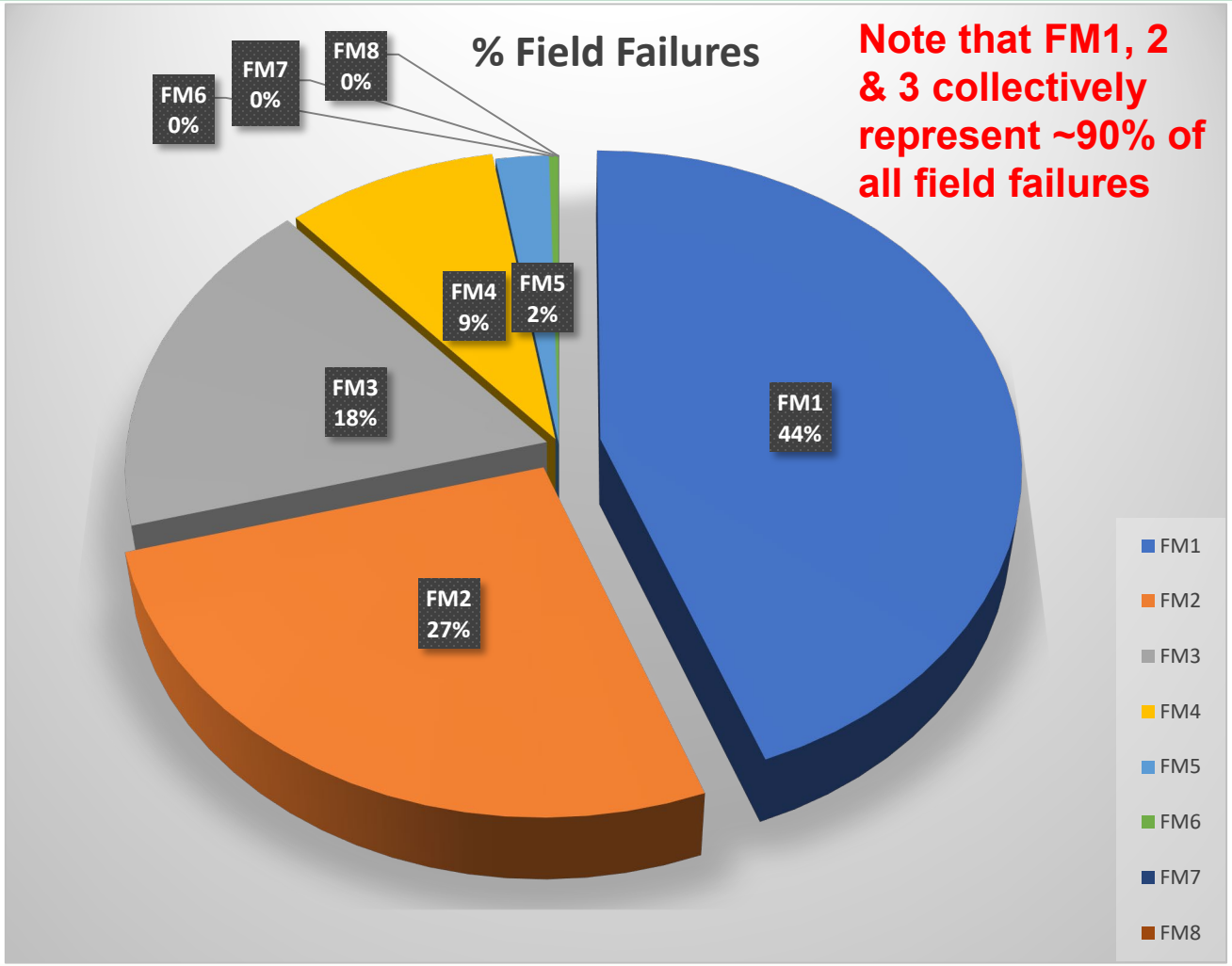
*(adapted for use) ISO13374-1 (2002). Condition Monitoring and Diagnostics of Machines Geneva, Switzerland

IVHM Functional Block	Description	IVHM Process Stage
Data Acquisition (DA)	This function collects the sensor data and health state information from the equipment internal monitors, the system data bus or data recorder.	Acquire
		Sense
Data Manipulation (DM)	This function processes and transforms the sensor data and health state information collected by the DA.	Transfer
State Detection (SD)	This function evaluates equipment state conditions against normal operating profiles and generates normal or abnormal condition indicators.	Analyze
Health Assessment (HA)	This function provides information to determine the current state of health of equipment.	
Prognostics Assessment (PA)	This function provides future state of health, performance life remaining, or remaining useful life (usage) indicators.	
Advisory Generation (AG)	This function provides actionable information to operational and maintenance personnel or external systems.	Act

FAILURE MODES PRIORITIZED BY FREQUENCY OF OCCURRENCE (HYPOTHETICAL EXAMPLE)

Failure Mode	IPTV Expected in 1st 5 * Years	% Field Failures
FM1	10.0000	44.2605
FM2	6.0000	26.5563
FM3	4.0000	17.7042
FM4	2.0000	8.8521
FM5	0.5000	2.2130
FM6	0.0900	0.3983
FM7	0.0030	0.0133
FM8	0.0005	0.0022
Total	22.5935	100.0000

*** or other reference period**
IPTV=Incidents Per Thousand Vehicles



OTHER DEFINITIONS TO BE USED LATER

- Frequency of failures (expressed as IPTV) as shown prior slide is clearly important and is specific to indicated portion of life cycle. It is unlikely for different failure modes to have uniform likelihood of occurrence in the field but, there are also other important factors to consider:
  - **Severity** (Type) – This measure tells us how important this failure mode is in terms of loss of functionality or its impact on vehicle safety
    - 5. ***Most Severe***: Non-operational Vehicle or Safety Issue
    - 4. Urgent Vehicle Repair
    - 3. Important Repair or Customer Inconvenience
    - 2. Minor Vehicle Repairs
    - 1. ***Least Severe:*** Routine Vehicle Maintenance
  - **Cost Per Vehicle** (CPV) – This measure tells us how costly on average it is to repair a vehicle once a given failure mode has happened (this is cost of all such repairs on a given population divided by the number of vehicles in that population)

IMPORTANT CAVEATS CONCERNING FIELD FAILURE DATA

- Getting a handle on Field Failure Data is central to the purposes of Health-Ready Components and SAE JA6268™. It is essentially the truth about component performance.
- While most of the burden for providing information about Health-Ready components falls upon the Supplier, it should be clear that the best Field Failure Data will likely come from the OEM, Integrator, or Operator and not necessarily the Supplier. That is, we assume that correctly portraying Field Failure Data in the Registry requires collaboration between the Supplier and whoever "owns" the Field Failure Data
- Another key issue is that brand new components will have no Field Failure history so we assume that it will be *initially* extrapolated from the most similar components for which field history is available
  - This implies that once a brand new component begins to develop a history of its own, there will be a need to update the HRCS Registry with the best available Field Failure Data

AIR7999 - DIAGNOSTIC AND PROGNOSTIC METRICS FOR ENGINE HEALTH MANAGEMENT SYSTEMS, APPENDIX A (DRAFT DEFINITIONS)

Metric Name	Definition	Description
Accuracy Based Metrics		
True Positive Rate (TPR)	$TPR = \frac{TP}{TP + FN} = P(D1\|F1)$	The proportion of fault conditions correctly detected. Also known as "sensitivity."
True Negative Rate (TNR)	$TNR = \frac{TN}{FP + TN} = P(D0\|F0)$	The proportion of no fault conditions correctly rejected as a fault. Also known as "specificity."
False Positive Rate (FPR)	$FPR = \frac{FP}{FP + TN} = P(D1\|F0)$	The proportion of no fault conditions incorrectly detected as a fault. Also known as "false alarm rate".
False Negative Rate (FNR)	$FNR = \frac{FN}{TP + FN} = P(D0\|F1)$	The proportion of fault conditions incorrectly rejected as a fault.
Positive Predictive Value (PPV)	$PPV = \frac{TP}{TP + FP} = P(F1\|D1)$	The proportion of positive fault prediction cases actually having a fault.
Negative Predictive Value (NPV)	$NPV = \frac{TN}{TN + FN} = P(F0\|D0)$	The proportion of negative fault prediction cases that are fault free.
False Discovery Rate (FDR)	$FDR = \frac{FP}{TP + FP} = P(F0\|D1)$	The proportion of positive fault prediction cases that are fault free.
False Omission Rate (FOR)	$FOR = \frac{FN}{TN + FN} = P(F1\|D0)$	The proportion of negative fault prediction cases actually having a fault.
Fault Detection Coverage	$C_D = \frac{N_{DF}}{N_{TF}} * 100\%$	The percentage of fault modes that can be detected.

True State \ Predicted State	Fault	No Fault
Fault	*TP (true positives)*	*FN (false negatives)*
No Fault	*FP (false positives)*	*TN (true negatives)*

A 2×2 matrix that reflects an algorithm's ability to discriminate between fault and no-fault cases. Its main diagonal reflects the number of correct predictions (true positives and true negatives) and its off-diagonal elements reflect the number of incorrect predictions (false negatives and false positives)

SAE JA6268™ THREE CERTIFICATION STAGES (NOTE: NOW AT COMPONENT/SUBSYSTEM LEVEL)

Stage 1: *Functional Self Assessment*

Stage 2: *Failure Modes Assessment*

Stage 3: *Detailed Design Assessment*

Note:

- *Stage 1 is intended to provide a provisional certification with a low barrier to entry. All Stage 1 information will be recorded in online HRCS Registry.*
- *Stages 2 & 3 are enhanced by seeking an OEM/ integrator to validate the more detailed supplier-provided assessments. Stage 2 & 3 submissions should be accompanied by Stage 1 info as well to populate registry. Stage 2 & 3 completion will be noted in HRCS Registry but the additional data will not be loaded since it contains potentially proprietary info.*

SAE HRCS HEALTH-READY COMPONENTS REGISTRY (CORE INFO) APPLIES TO STAGE 1, 2 & 3

(SAE JA6268™ Chapter 9)

- Component Name (and known aliases)
- Supplier Name & Sector(s) (e.g., Aero, Auto, …)
- Supplier's catalog reference number (or numbers)
- Suppliers contact information and DUNS number, CAGE Code or other industry standard supplier identifier (if applicable)
- Validation approach can be based upon (a) design-time information, (b) run time information or (c) both design-time and run-time information
- Format of Health Ready info which provides a mathematical model (or mathematical relationships) in a machine-readable format to allow for a proper interpretation and use of specific component parameters
- Integrator/OEM name providing the validation along with their contact information and DUNS number (if applicable)
- Dates validation was completed and date which the validation expires (if applicable)

\+ *Other items to be determined by HRCS SG (all non-proprietary)*

SAE HRCS HEALTH-READY COMPONENTS REGISTRY

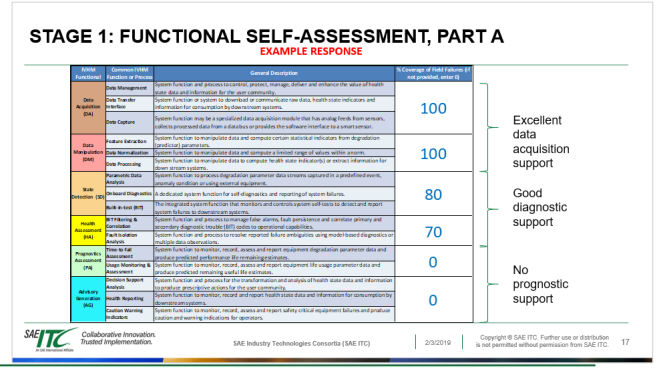
Stage 1

STAGE 1: FUNCTIONAL SELF-ASSESSMENT, PART A WORKSHEET

Part A only requires 6 entries (0-100%) to estimate Health-Readiness for each of the ISO categories

IVHM Functional	Common IVHM Function or Process	General Description	% Coverage of Field Failures (if not provided, enter 0)
Data Acquisition (DA)	Data Management	System function and process to control, protect, manage, deliver and enhance the value of health state data and information for the user community.	0
	Data Transfer Interface	System function or system to download or communicate raw data, health state indicators and information for consumption by downstream systems.	
	Data Capture	System function may be a specialized data acquisition module that has analog feeds from sensors, collects processed data from a data bus or provides the software interface to a smart sensor.	
Data Manipulation (DM)	Feature Extraction	System function to manipulate data and compute certain statistical indicators from degradation (predictor) parameters.	0
	Data Normalization	System function to manipulate data and compute a limited range of values within a norm.	
	Data Processing	System function to manipulate data to compute health state indicator(s) or extract information for down stream systems.	
State Detection (SD)	Parametric Data Analysis	System function to process degradation parameter data streams captured in a predefined event, anomaly condition or using external equipment.	0
	Onboard Diagnostics	A dedicated system function for self-diagnostics and reporting of system failures.	
	Built-in-test (BIT)	The integrated system function that monitors and controls system self-tests to detect and report system failures to downstream systems.	
Health Assessment (HA)	BIT Filtering & Correlation	System function and process to manage false alarms, fault persistence and correlate primary and secondary diagnostic trouble (BIT) codes to operational capabilities.	0
	Fault Isolation Analysis	System function and process to resolve reported failure ambiguities using model-based diagnostics or multiple data observations.	
Prognostics Assessment (PA)	Time-to-fail Assessment	System function to monitor, record, assess and report equipment degradation parameter data and produce predicted performance life remaining estimates.	0
	Usage Monitoring & Assessment	System function to monitor, record, assess and report equipment life usage parameter data and produce predicted remaining useful life estimates.	
Advisory Generation (AG)	Decision Support Analysis	System function and process for the transformation and analysis of health state data and information to produce prescriptive actions for the user community.	0
	Health Reporting	System function to monitor, record and report health state data and information for consumption by downstream systems.	
	Caution Warning Indicators	System function to monitor, record, assess and report safety critical equipment failures and produce caution and warning indications for operators.	

CLICK BELOW FOR EXAMPLE



STAGE 1: FUNCTIONAL SELF-ASSESSMENT, PART A

EXAMPLE RESPONSE

IVHM Functional	Common IVHM Function or Process	General Description	% Coverage of Field Failures (if not provided, enter 0)
Data Acquisition (DA)	Data Management	System function and process to control, protect, manage, deliver and enhance the value of health state data and information for the user community.	100
	Data Transfer Interface	System function or system to download or communicate raw data, health state indicators and information for consumption by downstream systems.	
	Data Capture	System function may be a specialized data acquisition module that has analog feeds from sensors, collects processed data from a data bus or provides the software interface to a smart sensor.	
Data Manipulation (DM)	Feature Extraction	System function to manipulate data and compute certain statistical indicators from degradation (predictor) parameters.	100
	Data Normalization	System function to manipulate data and compute a limited range of values within a norm.	
	Data Processing	System function to manipulate data to compute health state indicator(s) or extract information for down stream systems.	
State Detection (SD)	Parametric Data Analysis	System function to process degradation parameter data streams captured in a predefined event, anomaly condition or using external equipment.	80
	Onboard Diagnostics	A dedicated system function for self-diagnostics and reporting of system failures.	
	Built-in-test (BIT)	The integrated system function that monitors and controls system self-tests to detect and report system failures to downstream systems.	
Health Assessment (HA)	BIT Filtering & Correlation	System function and process to manage false alarms, fault persistence and correlate primary and secondary diagnostic trouble (BIT) codes to operational capabilities.	70
	Fault Isolation Analysis	System function and process to resolve reported failure ambiguities using model-based diagnostics or multiple data observations.	
Prognostics Assessment (PA)	Time-to-fail Assessment	System function to monitor, record, assess and report equipment degradation parameter data and produce predicted performance life remaining estimates.	0
	Usage Monitoring & Assessment	System function to monitor, record, assess and report equipment life usage parameter data and produce predicted remaining useful life estimates.	
Advisory Generation (AG)	Decision Support Analysis	System function and process for the transformation and analysis of health state data and information to produce prescriptive actions for the user community.	0
	Health Reporting	System function to monitor, record and report health state data and information for consumption by downstream systems.	
	Caution Warning Indicators	System function to monitor, record, assess and report safety critical equipment failures and produce caution and warning indications for operators.	

Excellent data acquisition support

Good diagnostic support

No prognostic support

STAGE 1: FUNCTIONAL SELF-ASSESSMENT, PART B

- **For Data Acquisition and Manipulation**
  - Machine Readable Info Exchange? (Y/N)
  - Machine Readable Conv of Raw Inputs to Eng Units? (Y/N)
  - Severity of Failures? (Range: 5-1)
- **For State Detection & Health Assessment**
  - Health Indicators ID'd? (Y/N)
  - Relationships/Models ID'd? (Y/N)
  - Diagnostic Metrics? (specify range & type)
- **For Prognostics Assessment & Advisory Generation**
  - Typical RUL Notice? (specify units if applicable)
  - Typical Std Dev for RUL? (specify units if applicable)
  - Prognostic Metrics? (specify range & type if applicable)

STAGE 1: FUNCTIONAL SELF-ASSESSMENT, PART B

EXAMPLE

- **For Data Acquisition and Manipulation**
  - Machine Readable Info Exchange? (Y/N) — **Y**
  - Machine Readable Conv of Raw Inputs to Eng Units? (Y/N) — **Y**
  - Severity of Failures? (Range: 5-1) — **4-3**
- **For State Detection & Health Assessment**
  - Health Indicators ID'd? (Y/N) — **Y**
  - Relationships/Models ID'd? (Y/N) — **Y**
  - Diagnostic Metrics? (specify range & type) — **30-40 % NTF**
- **For Prognostics Assessment & Advisory Generation**
  - Typical RUL Notice? (specify units if applicable) — **14 days**
  - Typical Std Dev for RUL? (specify units if applicable) — **4 days**
  - Prognostic Metrics? (specify range & type if applicable) — **99% TPR; 90% TNR**

Typically, Stage 1 Functional Self-Assessments won't have any Prognostic Assessment or Advisory Generation information to provide but potential data illustrated here

SAE HRCS HEALTH-READY COMPONENTS REGISTRY

Stage 2

STAGE 2: FAILURE MODES ASSESSMENT

Similar to Stage 1 but based on each individual failure mode instead of aggregate performance

EXAMPLE

	Failure Mode Descrip-tion	% Field Failures	Severity of Failure (5-1)	Avg Cost of Repairs (CPV) $	Health Indicators ID'd (describe)	Relationships / Models ID'd (describe)	Machine Readable Information Exchange? (Y/N)	Machine Readable Conv of Raw Inputs to Eng Units? (Y/N)	Typical RUL Notice (selected units if predicted)	Diagnostic Metrics (selected type if available)	Prognostic Metrics (selected type if available)	Data Acquisition & Manipulation (DA & DM) % Coverage for Given Failure Mode	State Detection & Health Assesment (SD & HA) % Coverage for Given Failure Mode	Prognostics Assessment & Advisory Generation (PA & AG) % Coverage for Given Failure Mode	•••
1	aaaa	45	3	50	YES	YES	YES	YES	--	50	--	90	75	0	
2	bbbb	20	4	100	YES	YES	YES	YES	--	60	--	100	40	0	
3	cccc	15	5	300	YES	YES	YES	YES	--	60	--	100	30	0	
4	dddd	15	3	200	NO	NO	YES	YES	--	60	--	100	25	0	
"n"	eeee	5	2	100	NO	NO	YES	YES	--	90	--	0	0	0	
	Sum <=100%	**100**									Sums weighted by % Field Failures	**90.5**	**50.0**	**0.0**	

Stated RUL Units:

- ○ Hours
- ● Days
- ○ Weeks
- ○ Months
- ○ Cycles (flights/trips/starts)
- ○ Engine Hrs
- ○ Operation Hrs
- ○ Other: _____

Diagnostic/Prognostic Performance Units*:

- ○ TPR/FPR
- ● TNR/FNR
- ○ PPV/NPV
- ○ FDR/FOR
- ○ C_D Coverage
- ○ NTF (or NFF)
- ○ RUL Standard Deviation
- ○ Diagnostic Ambiguity Group Size

* AIR7999 - Diagnostic and Prognostic Metrics for Engine Health Management Systems, Apprendix A (Draft)

SAE HRCS HEALTH-READY COMPONENTS REGISTRY

Stage 3

STAGE 3: DETAILED DESIGN ASSESSMENT (16 TABLES)

Stage 3 is the most complete, providing design data. Each table has clarifying information for the covered topics.

ISO 13374 (OSA-CBM) Implementation Level / SAE JA6268™ Interface Name			None	Data Acquisition (DA)	Data Manipulation (DM)	State Detection (SD)	Health Assessment (HA)	Prognostic Assessment (PA)	Advisory Generation (AG)
Design-Time Interfaces	1	Table of Corrective Actions	X	X	X	X	X	X	X
	2	Table of Interfaces	X	X	X	X	X		
	3	Table of Parameters	X	X					
	4	Table of Failure Modes	X	X	X	X			
	5	Table of Condition Indicators			X	X			
	6	Table of Health Indicators				X	X	X	
	7	Table of Predictive Indicators					X	X	
	8	Table of Reported State/Mode Indicators		X	X	X	X	X	
	9	Table of Loadable Software and Data Files	X	X	X	X	X	X	X
	10	Table of Automatically Reported Configuration Indicators				X	X	X	X
	11	Table of Internally Managed Data Recordings				X	X	X	X
	12	Table of Suggested, Externally Managed, Data Recordings	X	X	X				
	13	Table of Suggested, Externally Executed Algorithms	X	X	X				
	14	Table of Corrective Actions to Health Indicator Relationships	X	X	X	X	X	X	
	15	Table of Corrective Actions to Interface Anomaly Relationships	X	X	X	X			
	16	Table of Indicator to State/Mode Validity Relationships	X	X	X	X			

HRC Download Composite Audit Worksheet

Download HRC Failure Mode Audit Worksheet

Download HRC Design Data Audit

Search

New Company

New Assembly

Company (Supplier) / Part Family / Part #	Integrator Verification	Part Type	Assessment Method	ISO 13374 (OSA-CBM) Implementation Level / 6268 Interface Name: Data Acquisition (DA)	Data Manipulation (DM)	State Detection (SD)	Health Assessment (HA)	Prognostic Assessment (PA)	Advisory Generation (AG)	Total Score	Assessment Files
Garrett Automotive											
2107X		Turbo Charger	Design Data Audit	100	100	95	95	65	0	75.8	
- 2107003		Turbo Charger	Failure Mode Audit	100	100	95	98	60	0	75.5	
	GM		Design Data Audit	100	100	95	98	60	0	75.5	
	PSA		Design Data Audit	100	100	95	85.5	60	0	73.4	
+ 2107004		Turbo Charger	Failure Mode Audit	100	100	95	98	60	5	76.3	
+ 2107004A		Turbo Charger	Failure Mode Audit	100	100	95	98	70	5	78.0	
+ 2107004B		Turbo Charger	Failure Mode Audit	100	100	95	98	70	0	77.2	
+ 2107006		Turbo Charger	Failure Mode Audit	100	100	95	98	60	10	77.2	
+ 2107009		Turbo Charger	Failure Mode Audit	100	100	95	98	60	10	77.2	
2141X		e-Turbo	Design Data Audit	95	95	90	95	70	70	85.8	
+ 2141001		e-Turbo	Composite Audit	95	95	90	95	70	70	85.8	
- 2141004		e-Turbo	Composite Audit	95	95	90	95	80	70	87.5	
	GM		Design Data Audit	95	95	90	95	80	70	87.5	
	BMW		Design Data Audit	95	95	90	95	80	70	87.5	
	FCA		Design Data Audit	95	95	90	95	80	70	87.5	
+ 2141007		e-Turbo	Composite Audit	95	95	90	95	80	70	87.5	
+ 2141007A		e-Turbo	Composite Audit	95	95	90	95	80	70	87.5	
+ 2141009		e-Turbo	Composite Audit	95	95	90	95	80	70	87.5	

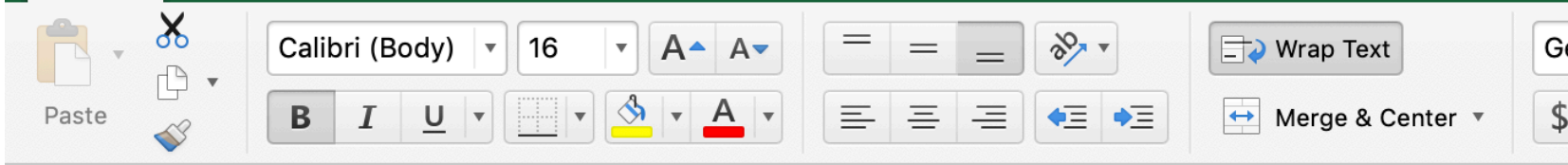
	A	B	C	D
1	**Company Name (Supplier):**			Garrett
2	**Company DUNS Number:**			897-4456-2108
3	**Assembly Part Number:**			2107003
4	**Assembly Description:**			550 HP, G-Series Turbocharger with Electrically Actuated Bypass and Wastegate Valves.
5	**Assembly Type:**			Turbocharger
6	**Assement Method:**			Design Data Submittal
7	**Sector:**			Automotive
8				
9	**Data Acquisition (DA):**			100
10	**Data Manipulation (DM):**			100
11	**State Detection (SD):**			95
12	**Health Assessment (HA):**			98
13	**Prognostic Assessment (PA):**			60
14	**Advisory Generation (AG):**			0

	A	B	C	D	E	F	G	H
1	Allow user to download official copy of the HRC Summary Assessment Worksheet							
2	Allow user to download official copy of the HRC Failure Mode Audit Worksheet							
3	Allow user to download official copy of the HRC Design Data Worksheet							
4	Allow user to create a new company							
5	Allow user to create a new Assembly							
6	Wrting to the site requires log in ID							
7	Allow user to Search using free text, compainies and Part Types							
8	Is data posted to working area and then it is approved by Admin							
9	User clicks on cell and gets additional detail							
10	Create a Assembly Family							
11	Link Assembly to Assembly Family							
12	Integrator can report audit							

	A	B
1	**id**	**Name**
2	15	AC Motor
3	37	Acoustic Imaging Sensor
4	54	Actuated Valve
5	33	Audio Input Device
6	32	Audio Output Device
7	42	Bearing
8	47	Belt
9	45	Chain
10	72	Chemical Reaction Chamber
11	81	Circuit Breaker
12	56	Compressor
13	61	Condensor
14	65	Crankshaft
15	63	Cylinder
16	16	DC Motor
17	68	Displacement Spring
18	71	Distillation Column
19	62	Duct
20	28	Electrical Connector
21	24	Electrical Generator
22	29	Electrical Harness
23	23	Electrical Power Distribution Unit
24	26	Electrical Switch
25	25	Electrical Transformer
26	17	Electronic Controller
27	19	Electronic IO Unit
28	20	Electronic Power Supply
29	18	Electronic Processing Unit
30	60	Evaporator
31	55	Fan
32	49	Fastening Device
33	74	Filter
34	77	Flow Sensor
35	43	Gear
36	58	Heat Exchanger

We created an SAE HRCS JA6268™ Certification workbook in Excel to facilitate submission of new components to the Registry. Drop down selections are offered where practical.

The first sheet of the workbook is shown on the right and provides a place to enter the Core Info common to all submittals.

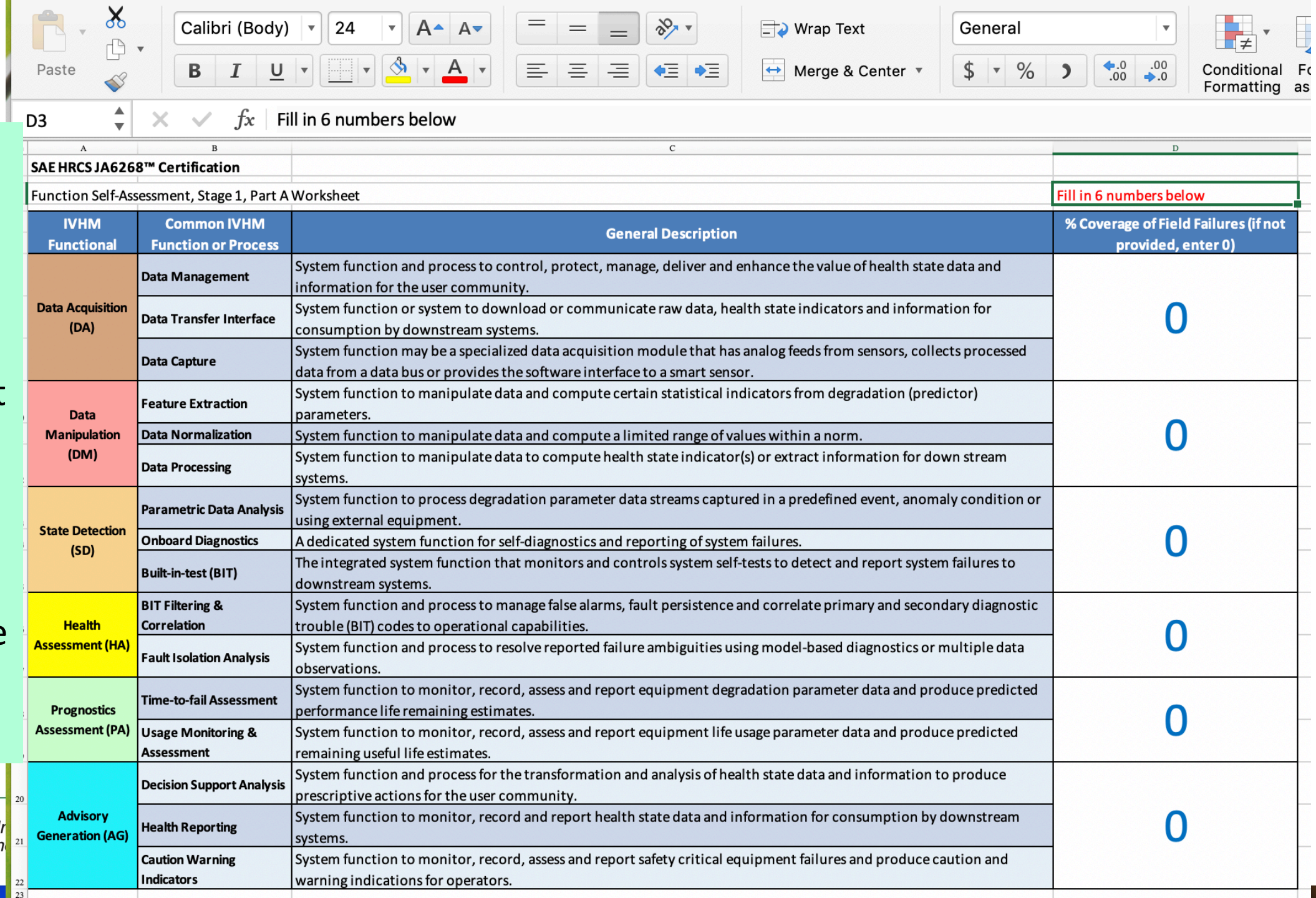


A1 | SAE HRCS JA6268™ Certification

	A	B	C
1	**SAE HRCS JA6268™ Certification**	**Stage Being Submitted**	**<select>**
2			
3	Core Info Required for All Submissions (Stages 1, 2 or 3)		Fill in Grey Boxes
4			
5	Field	Description / Examples	Response
6	Component Name	Antilock Brake System	
7	Known Aliases	ABS	
8	Supplier Name	XYZ Company	
9	Sector	Automotive	<select>
10	Catalog Reference Number(s)	12 3456 7890	
11	HRCS Certification Stage	1	<select>
12	Supplier Contact Name	John Doe	
13	Supplier Contact email	john.doe@xyz.com	
14	Supplier Contact Phone	+1 (888) 123-4567	
15	Supplier Contact Address		
16	DUNS Number (if applicable)		
17	CAGE Number (if applicable)		
18	Other Industry Standard Supplier Identifier (if applicable)		
19	Primary Validation Approach	Combined Design & Run-Time Info	<select>
20	Format of Health-Ready Information	XLS templated form	<select>
21	OEM or Integrator Name	Giant Motors Company	
22	OEM/Integrator Contact Name	Jane Doe	
23	OEM/Integrator Contact email	jane.doe@giant.com	
24	OEM/Integrator Contact Phone	+1 (888) 123-4567	
25	OEM/Integrator Contact Address		
26	Date Validation Certified	2/1/19	
27	Date Validation Expires	2/1/24	
28			

SAE HRCS JA6268™ Certification workbook:

The second sheet of the workbook is shown on the right and provides a place to enter coverage percentages for Stage 1.



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D3 Fill in 6 numbers below

SAE HRCS JA6268™ Certification

Function Self-Assessment, Stage 1, Part A Worksheet

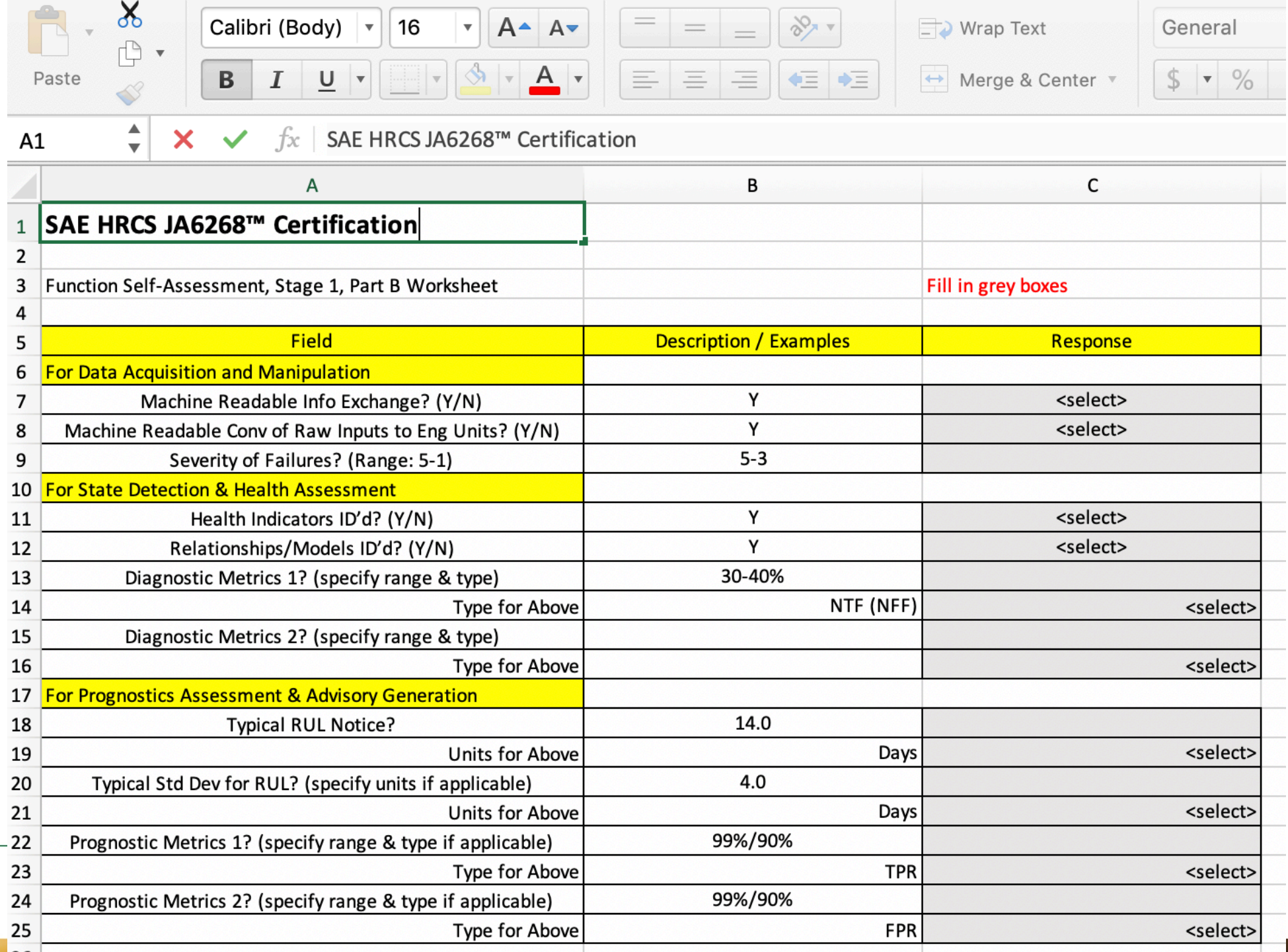
Fill in 6 numbers below

IVHM Functional	Common IVHM Function or Process	General Description	% Coverage of Field Failures (if not provided, enter 0)
Data Acquisition (DA)	Data Management	System function and process to control, protect, manage, deliver and enhance the value of health state data and information for the user community.	0
	Data Transfer Interface	System function or system to download or communicate raw data, health state indicators and information for consumption by downstream systems.	
	Data Capture	System function may be a specialized data acquisition module that has analog feeds from sensors, collects processed data from a data bus or provides the software interface to a smart sensor.	
Data Manipulation (DM)	Feature Extraction	System function to manipulate data and compute certain statistical indicators from degradation (predictor) parameters.	0
	Data Normalization	System function to manipulate data and compute a limited range of values within a norm.	
	Data Processing	System function to manipulate data to compute health state indicator(s) or extract information for down stream systems.	
State Detection (SD)	Parametric Data Analysis	System function to process degradation parameter data streams captured in a predefined event, anomaly condition or using external equipment.	0
	Onboard Diagnostics	A dedicated system function for self-diagnostics and reporting of system failures.	
	Built-in-test (BIT)	The integrated system function that monitors and controls system self-tests to detect and report system failures to downstream systems.	
Health Assessment (HA)	BIT Filtering & Correlation	System function and process to manage false alarms, fault persistence and correlate primary and secondary diagnostic trouble (BIT) codes to operational capabilities.	0
	Fault Isolation Analysis	System function and process to resolve reported failure ambiguities using model-based diagnostics or multiple data observations.	
Prognostics Assessment (PA)	Time-to-fail Assessment	System function to monitor, record, assess and report equipment degradation parameter data and produce predicted performance life remaining estimates.	0
	Usage Monitoring & Assessment	System function to monitor, record, assess and report equipment life usage parameter data and produce predicted remaining useful life estimates.	
Advisory Generation (AG)	Decision Support Analysis	System function and process for the transformation and analysis of health state data and information to produce prescriptive actions for the user community.	0
	Health Reporting	System function to monitor, record and report health state data and information for consumption by downstream systems.	
	Caution Warning Indicators	System function to monitor, record, assess and report safety critical equipment failures and produce caution and warning indications for operators.	

SAE ITC An SAE International Affiliate Collaborative In Trusted Implem

SAE HRCS JA6268™ Certification workbook:

The third sheet of the workbook is shown on the right and provides a place to enter the remaining info for Stage 1.



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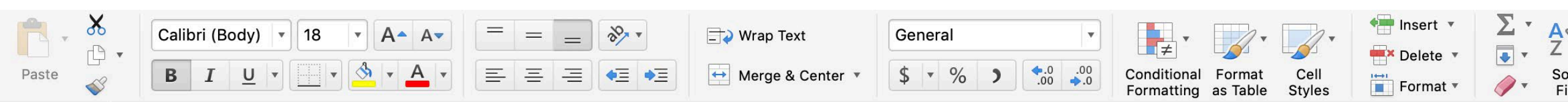
A1 | SAE HRCS JA6268™ Certification

	A	B	C
1	**SAE HRCS JA6268™ Certification**		
2			
3	Function Self-Assessment, Stage 1, Part B Worksheet		Fill in grey boxes
4			
5	Field	Description / Examples	Response
6	For Data Acquisition and Manipulation		
7	Machine Readable Info Exchange? (Y/N)	Y	<select>
8	Machine Readable Conv of Raw Inputs to Eng Units? (Y/N)	Y	<select>
9	Severity of Failures? (Range: 5-1)	5-3	
10	For State Detection & Health Assessment		
11	Health Indicators ID'd? (Y/N)	Y	<select>
12	Relationships/Models ID'd? (Y/N)	Y	<select>
13	Diagnostic Metrics 1? (specify range & type)	30-40%	
14	Type for Above	NTF (NFF)	<select>
15	Diagnostic Metrics 2? (specify range & type)		
16	Type for Above		<select>
17	For Prognostics Assessment & Advisory Generation		
18	Typical RUL Notice?	14.0	
19	Units for Above	Days	<select>
20	Typical Std Dev for RUL? (specify units if applicable)	4.0	
21	Units for Above	Days	<select>
22	Prognostic Metrics 1? (specify range & type if applicable)	99%/90%	
23	Type for Above	TPR	<select>
24	Prognostic Metrics 2? (specify range & type if applicable)	99%/90%	
25	Type for Above	FPR	<select>



A1 SAE HRCS JA6268™ Certification

SAE HRCS JA6268™ Certification

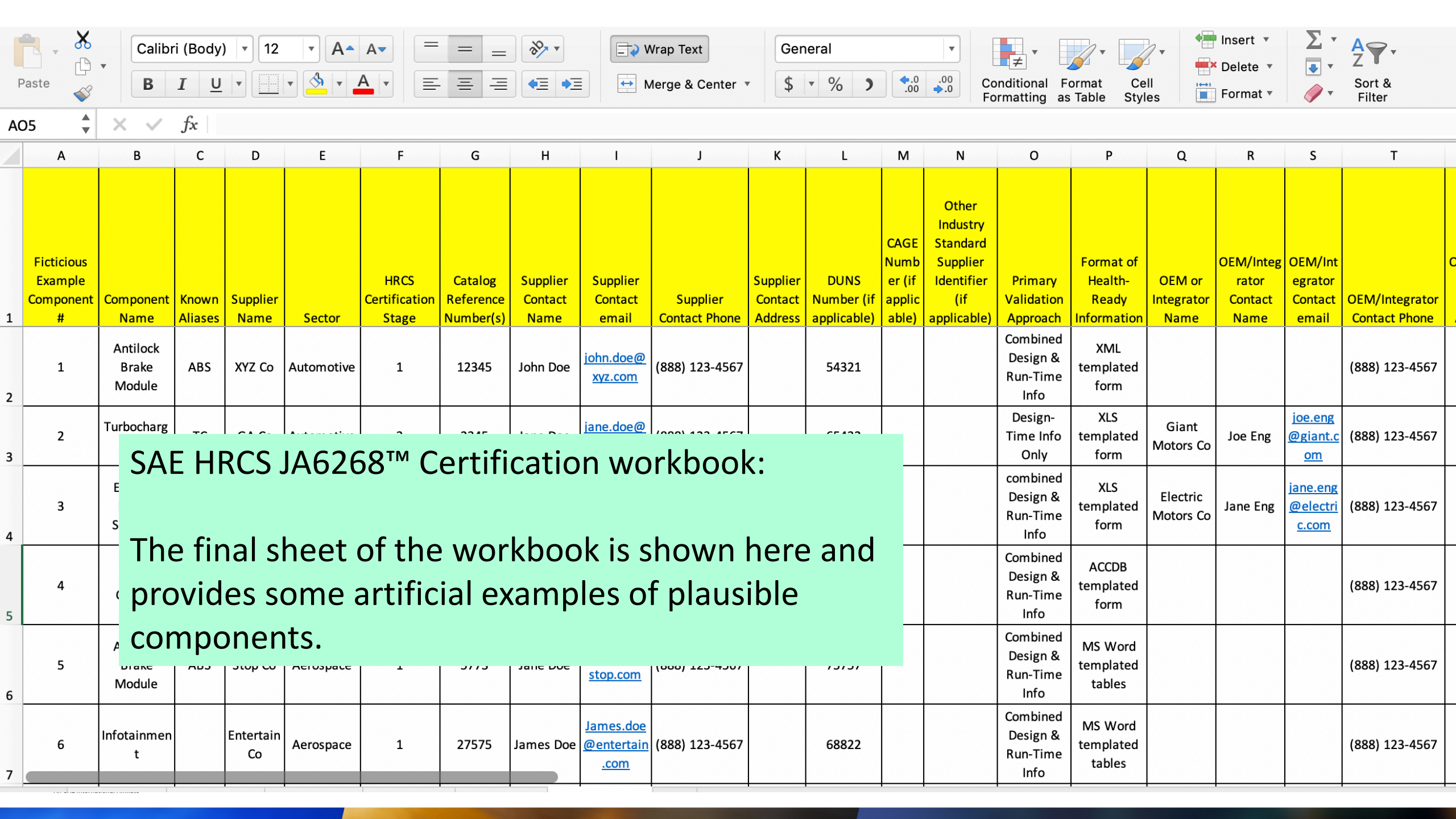
Failure Modes Assessment, Stage 2 Worksheet

Fill in one row for each known failure mode; add as many rows as necessary

	Failure Mode Descrip-tion	% Field Failures	Severity of Failure (5-1)	Avg Cost of Repairs (CPV) $	Health Indicators ID'd (describe)	Relationships / Models ID'd (describe)	Machine Readable Information Exchange? (Y/N)	Machine Readable Conv of Raw Inputs to Eng Units? (Y/N)	Typical RUL Notice (selected units if predicted)	Diagnostic Metrics (selected type if available)	Prognostic Metrics (selected type if available)	Data Acquisition & Manipulation (DA & DM) % Coverage for Given Failure Mode	State Detection & Health Assesment (SD & HA) % Coverage for Given Failure Mode	Prognostics Assessment & Advisory Generation (PA & AG) % Coverage for Given Failure Mode
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
	Sum <=100%	0.0%								Sums weighted by % Field Failures		0.0%	0.0%	0.0%

SAE HRCS JA6268™ Certification workbook:

The third sheet of the workbook is shown here and provides a place to enter the more detailed Stage 2 info for each of the known failure modes.

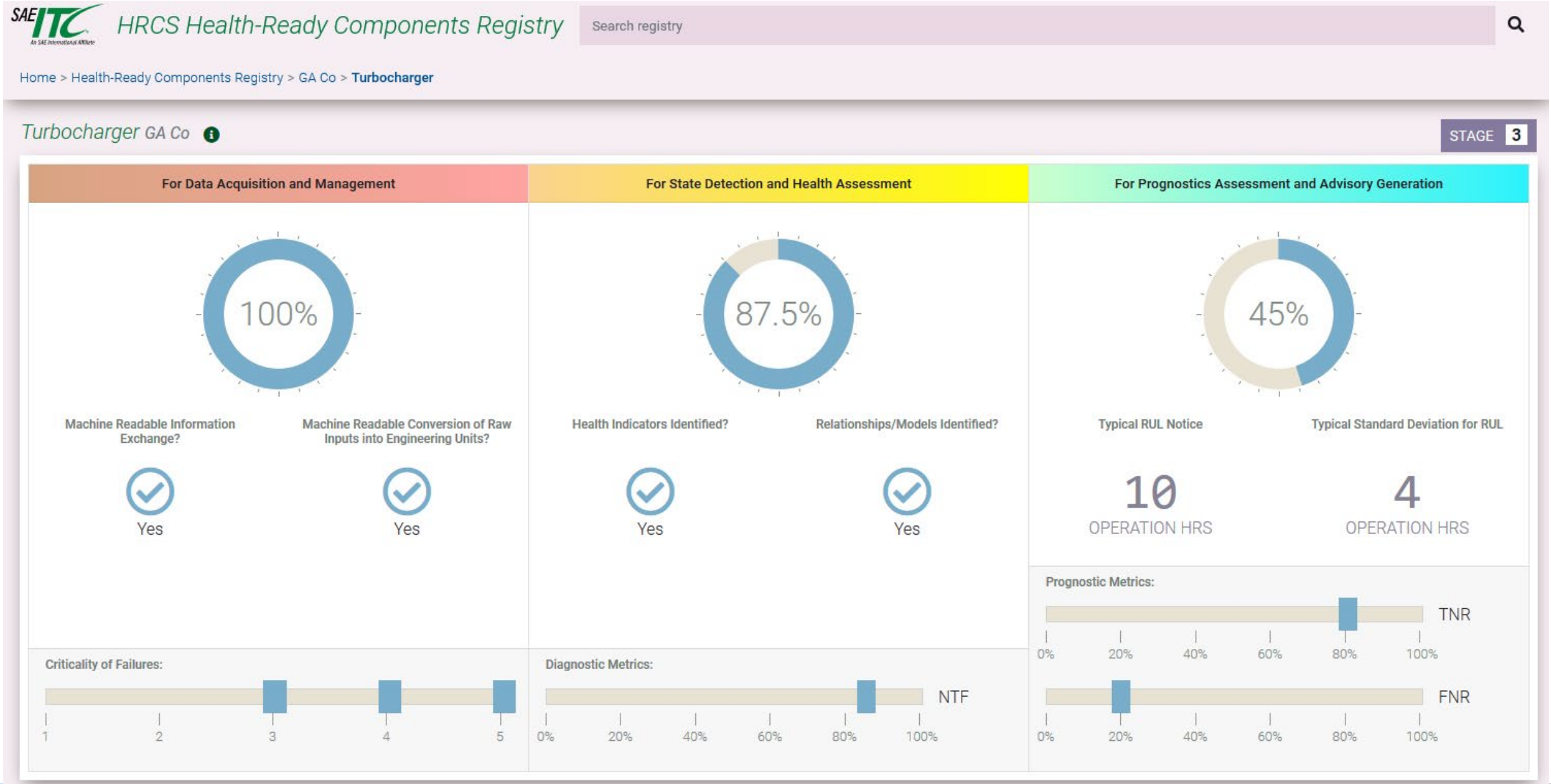


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Ficticious Example Component #	Component Name	Known Aliases	Supplier Name	Sector	HRCS Certification Stage	Catalog Reference Number(s)	Supplier Contact Name	Supplier Contact email	Supplier Contact Phone	Supplier Contact Address	DUNS Number (if applicable)	CAGE Number (if applicable)	Other Industry Standard Supplier Identifier (if applicable)	Primary Validation Approach	Format of Health-Ready Information	OEM or Integrator Name	OEM/Integrator Contact Name	OEM/Integrator Contact email	OEM/Integrator Contact Phone
2	1	Antilock Brake Module	ABS	XYZ Co	Automotive	1	12345	John Doe	john.doe@xyz.com	(888) 123-4567		54321			Combined Design & Run-Time Info	XML templated form				(888) 123-4567
3	2	Turbocharg							jane.doe@						Design-Time Info Only	XLS templated form	Giant Motors Co	Joe Eng	joe.eng@giant.com	(888) 123-4567
4	3														combined Design & Run-Time Info	XLS templated form	Electric Motors Co	Jane Eng	jane.eng@electric.com	(888) 123-4567
5	4														Combined Design & Run-Time Info	ACCDB templated form				(888) 123-4567
6	5	Brake Module							stop.com						Combined Design & Run-Time Info	MS Word templated tables				(888) 123-4567
7	6	Infotainment		Entertain Co	Aerospace	1	27575	James Doe	James.doe@entertain.com	(888) 123-4567		68822			Combined Design & Run-Time Info	MS Word templated tables				(888) 123-4567

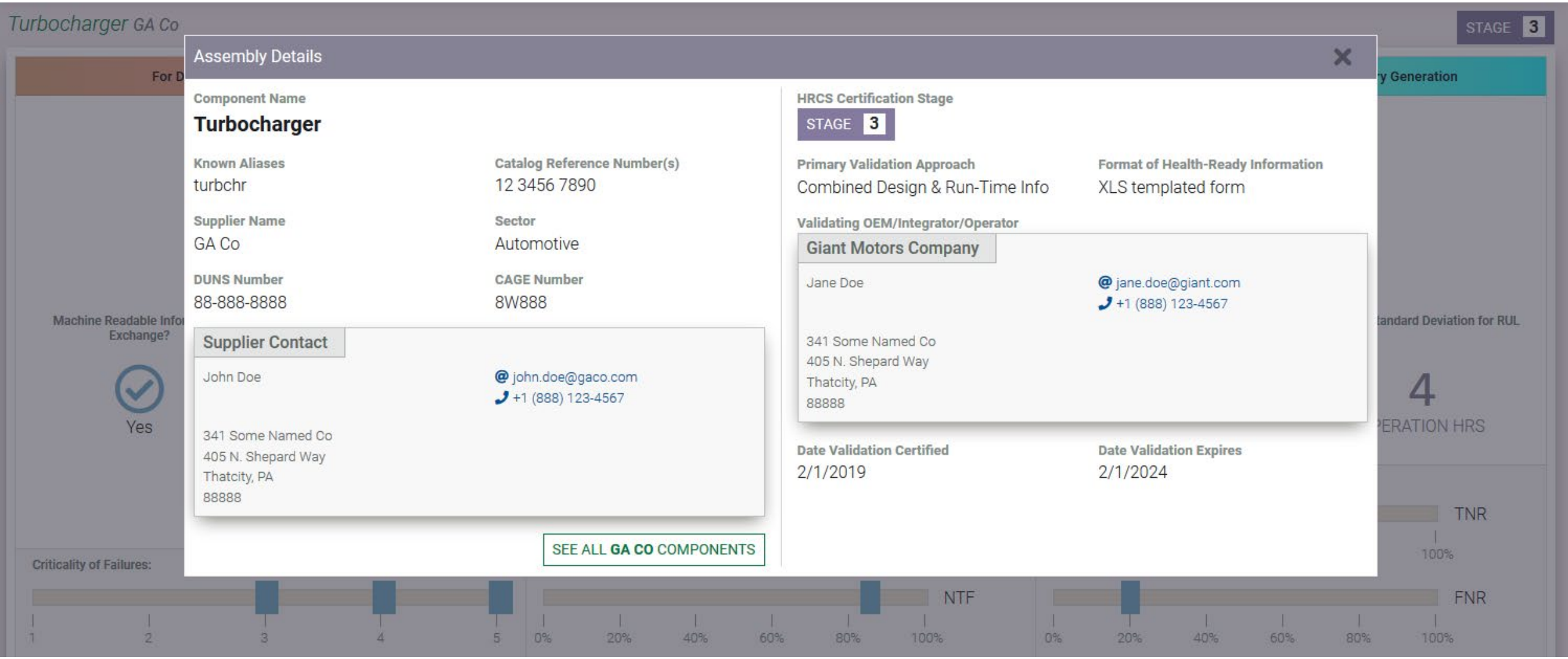
SAE HRCS JA6268™ Certification workbook:

The final sheet of the workbook is shown here and provides some artificial examples of plausible components.

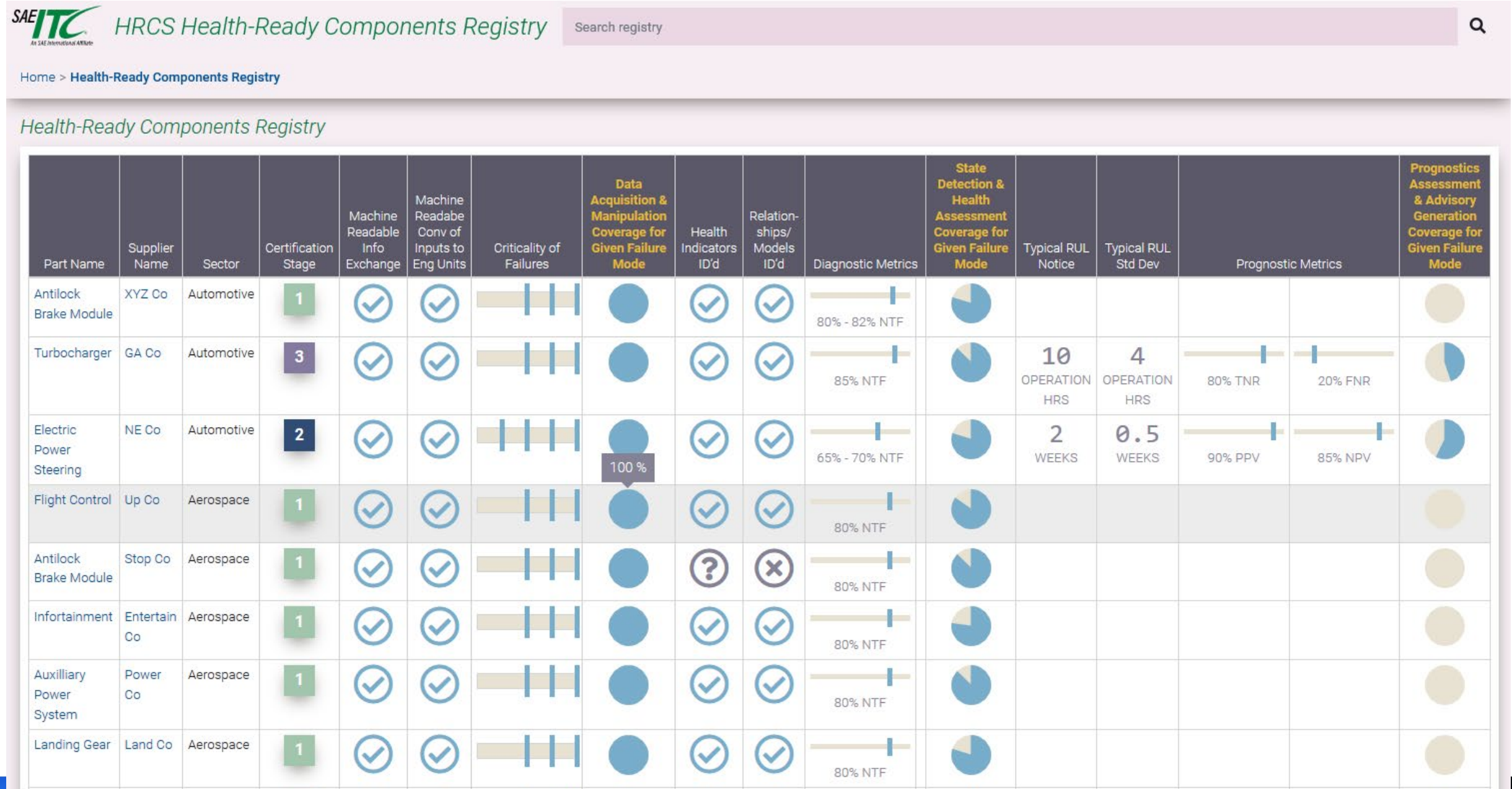
SINGLE COMPONENT VIEWING SCREEN IN REGISTRY



SINGLE COMPONENT ADDITIONAL DETAILS VIEW IN REGISTRY



MULTIPLE COMPONENT VIEWING SCREEN FROM REGISTRY



Part Name	Supplier Name	Sector	Certification Stage	Machine Readable Info Exchange	Machine Readabe Conv of Inputs to Eng Units	Criticality of Failures	Data Acquisition & Manipulation Coverage for Given Failure Mode	Health Indicators ID'd	Relation-ships/ Models ID'd	Diagnostic Metrics	State Detection & Health Assessment Coverage for Given Failure Mode	Typical RUL Notice	Typical RUL Std Dev	Prognostic Metrics		Prognostics Assessment & Advisory Generation Coverage for Given Failure Mode
Antilock Brake Module	XYZ Co	Automotive	1	✓	✓			✓	✓	80% - 82% NTF						
Turbocharger	GA Co	Automotive	3	✓	✓			✓	✓	85% NTF		10 OPERATION HRS	4 OPERATION HRS	80% TNR	20% FNR	
Electric Power Steering	NE Co	Automotive	2	✓	✓		100 %	✓	✓	65% - 70% NTF		2 WEEKS	0.5 WEEKS	90% PPV	85% NPV	
Flight Control	Up Co	Aerospace	1	✓	✓			✓	✓	80% NTF						
Antilock Brake Module	Stop Co	Aerospace	1	✓	✓			?	✗	80% NTF						
Infortainment	Entertain Co	Aerospace	1	✓	✓			✓	✓	80% NTF						
Auxilliary Power System	Power Co	Aerospace	1	✓	✓			✓	✓	80% NTF						
Landing Gear	Land Co	Aerospace	1	✓	✓			✓	✓	80% NTF						

CONSORTIUM DEVELOPMENT

Mission

SAE Industry Technologies Consortia (ITC) enables organizations to connect, collaborate and positively impact global industries by empowering implementation of precompetitive solutions and innovative technologies.

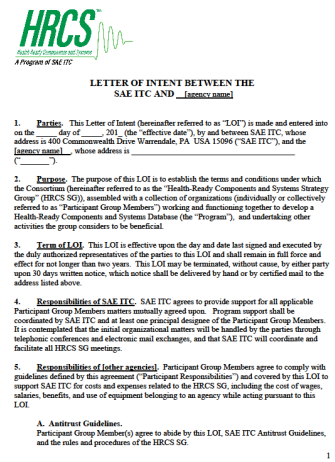
Vision

We are a trusted global leader in consortia-based collaborative tools and services for highly technical industries' operations and supply chain, especially automotive and aerospace.

Collaborative Innovation. Trusted Implementation.

HRCS STRATEGY GROUP LETTER OF INTENT AND CHARTER

HRCS™
Health Ready Components and Systems
A Program of SAE ITC


HRCS™
Health Ready Components and Systems
A Program of SAE ITC

LETTER OF INTENT BETWEEN THE
SAE ITC AND __[agency name]

1. Parties. This Letter of Intent (hereinafter referred to as "LOI") is made and entered into on the ____ day of ____, 201_ (the "effective date"), by and between SAE ITC, whose address is 400 Commonwealth Drive Warrendale, PA USA 15096 ("SAE ITC"), and the [agency name] , whose address is _____ ("_____").

2. Purpose. The purpose of this LOI is to establish the terms and conditions under which the Consortium (hereinafter referred to as the "Health-Ready Components and Systems Strategy Group" (HRCS SG)), assembled with a collection of organizations (individually or collectively referred to as "Participant Group Members") working and functioning together to develop a Health-Ready Components and Systems Database (the "Program"), and undertaking other activities the group considers to be beneficial.

3. Term of LOI. This LOI is effective upon the day and date last signed and executed by the duly authorized representatives of the parties to this LOI and shall remain in full force and effect for not longer than two years. This LOI may be terminated, without cause, by either party upon 30 days written notice, which notice shall be delivered by hand or by certified mail to the address listed above.

4. Responsibilities of SAE ITC. SAE ITC agrees to provide support for all applicable Participant Group Members matters mutually agreed upon. Program support shall be coordinated by SAE ITC and at least one principal designee of the Participant Group Members. It is contemplated that the initial organizational matters will be handled by the parties through telephonic conferences and electronic mail exchanges, and that SAE ITC will coordinate and facilitate all HRCS SG meetings.

5. Responsibilities of [other agencies]. Participant Group Members agree to comply with guidelines defined by this agreement ("Participant Responsibilities") and covered by this LOI to support SAE ITC for costs and expenses related to the HRCS SG, including the cost of wages, salaries, benefits, and use of equipment belonging to an agency while acting pursuant to this LOI.

A. Antitrust Guidelines.
Participant Group Member(s) agree to abide by this LOI, SAE ITC Antitrust Guidelines, and the rules and procedures of the HRCS SG.

1

LETTER OF INTENT BETWEEN THE SAE ITC AND __[agency name]

1. Parties. This Letter of Intent (hereinafter referred to as "LOI") is made and entered into on the _____ day of _____, 201_ (the "effective date"), by and between SAE ITC, whose address is 400 Commonwealth Drive Warrendale, PA USA 15096 ("SAE ITC"), and the __[agency name]__, whose address is _____ ("_____").

HRCS STRATEGY GROUP LETTER OF INTENT AND CHARTER

- Purpose of Letter of Intent (LOI)
  - Outline of anticipated responsibilities, benefits, and scope
  - Identify champions within prospective member companies
  - No financial commitment at this time
  - Interested parties who sign up will have primary input to Membership Agreement
  - Timing- response by March 1st

- Purpose of Membership Agreement
  - Defines membership levels and associated privileges
  - Forms a structure to manage new initiatives
  - Anticipated 3 membership levels, pricing to be established
  - Timing- launched by April 2nd

HRCS DATABASE AND OTHER ACTIVITIES

- Listings:
  - All new listings free of charge for calendar 2019
  - Incentive pricing for families of parts
  - Discounted listing fees thereafter commensurate with membership level
  - SAE certification seal by Stage (certification level) for improved product branding
- Conference with HRCS track and exhibition later in 2019

QUESTIONS?

THANK YOU!