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Data Management SPICE – Process Reference- and Assessment Model

Data Management SPICE

intacs® Working Group Data Management SPICE

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Table of Contents

Data Management SPICE – Process Reference- and Assessment Model 1
0. Preamble 6
0.1 Trademarks 6
0.2 Copyright notice 6
0.3 Distribution of this document 7
0.4 Community of interest 7
0.5 Change request handling 7
0.6 References 7
0.7 Terms, definitions, information item characteristics and abbreviations 9
1. Introduction 21
1.1 Purpose 22
1.2 Process Reference and Assessment Model 23
1.3 Scope 24
2. Data management process dimension: reference processes & performance indicators (CL1) & rating rules 25
2.1 Managing Data process group (MGD) 26
2.1.1 MGD.1 Data management scope and business case 26
2.1.2 MGD.2 Requirements for data management and data quality 30
2.1.3 MGD.3 Data management system and data flows 35
2.2 Data Operations process group (DOP) 39
2.2.1 DOP.1 Data integration and deployment 39
2.2.2 DOP.2 Data operations and optimization 43
2.3 Management process group (MAN) 46
2.3.1 MAN.3 Project Management 46
2.3.2 MAN.5 Risk Management 46
2.4 Acquisition process group (ACQ) 46
2.4.1 ACQ.4 Supplier Monitoring 46
2.5 Supporting process group (SUP) 46
2.5.1 SUP.1 Quality Assurance 46
2.5.2 SUP.8 Configuration Management 46
2.5.3 SUP.9 Problem Management 46
2.5.4 SUP.10 Change Request Management 46
2.6 Supply process group (SPL) 46
2.6.1 SPL.2 Product Release 46
2.7 Process improvement process group (PIM) 46

2.7.1 PIM.3 Process Improvement 46
3. Process capability dimension: process capability levels and process attributes 47
3.1 Process capability level 0: Incomplete process 47
3.2 Process capability level 1: Performed process 48
3.2.1 PA 1.1 Process performance process attribute 48
3.3 Process capability level 2: Managed process 49
3.3.1 PA 2.1 Process performance management process attribute....49
3.3.2 PA 2.2 Work product management process attribute 52
3.4 Process capability level 3: Established process 54
3.4.1 PA 3.1 Process definition process attribute 54
3.4.2 PA 3.2 Process deployment process attribute 57
3.5 Process capability level 4: Predictable process 59
3.5.1 PA 4.1 Quantitative analysis process attribute 59
3.5.2 PA 4.2 Quantitative control process attribute 61
3.6 Process capability level 5: Innovating process 63
3.6.1 PA 5.1 Process innovation process attribute....63
3.6.2 PA 5.2 Process innovation implementation process attribute....64
Annex A – Conformity of the Data Management SPICE PRM/PAM 66
Annex B – Data Management SPICE guideline on interpretation of Automotive SPICE® PRM/PAM 69
Annex B.1 – MAN.3 Project Management.... 69
Annex B.2 – MAN.5 Risk Management.... 71
Annex B.3 – ACQ.4 Supplier Monitoring.... 72
Annex B.4 – SUP.1 Quality Assurance.... 73
Annex B.5 – SUP.8 Configuration Management.... 73
Annex B.6 – SUP.9 Problem Resolution Management 74
Annex B.7 – SUP.10 Change Request Management.... 75
Annex B.8 – SPL.2 Product Release 76
Annex B.9 – PIM.3 Process Improvement 78
Annex C – Guideline for interfaces and comparisons of Data Management SPICE to other standards 79
Annex C.1 Interface to Machine Learning as part of Automotive SPICE PAM 4.0.... 79
Annex C.2 Interface to the Information Security Management Systems (ISMS) standard ISO 27001... 80
Annex C.3 Interface to the Cybersecurity Engineering Standard for Road Vehicles ISO/SAE 21434 82
Annex C.4 Interfaces to IT service management standards SPICE for IT-Services, ITIL, ISO 20000..... 84
Annex D – Data Management SPICE guideline regarding the role of senior management 87

Tables

Table 1: Specific and generic terminology for data management including information item characteristics 20
Table 2: Comparing Data Management SPICE and Machine Learning in Automotive SPICE....79
Table 3: Comparing Data Management SPICE and ISO 27001 81
Table 4: Comparing Data Management SPICE and ISO/SAE 21434 83
Table 5: Comparing Data Management SPICE and SPICE for IT-Services....85

Figures

Figure 1: Data Management SPICE process reference model - overview....23

0. Preamble

0.1 Trademarks

Automotive SPICE® is a registered trademark of the Verband der Automobilindustrie e.V. (VDA)

For further information about Automotive SPICE® visit www.vda-qmc.de.
intacs® is a registered trademark of International Assessor Certification Scheme e.V. in the EU, US, JAPAN, Korea, India and China.

0.2 Copyright notice

This document may reproduce relevant material from:

- ISO/IEC 33020:2019 (Information technology -– Process assessment -– Process measurement framework for assessment of process capability).

  It provides the following copyright release statement:
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- The Automotive SPICE® Process Reference Model and Process Assessment Model Version 4.0 for which permission has been granted by the SPICE User Group and the VDA QMC.

0.3 Distribution of this document

Released versions of this document can be obtained freely from the intacs website (https://www.intacs.info/). It is permitted for the recipient to distribute this document without modification.

0.4 Community of interest

This Data Management SPICE PRM/PAM has been created

1. by consensus of supplier and consultancy companies based in several countries organized in a working group set up and monitored by intacs e.V. (https://www.intacs.info/).
2. in accordance with the requirements of ISO/IEC 33004 [4] (see Annex A).

0.5 Change request handling

Any problems or change requests shall be reported via the ticketing system on www.intacs.info. Please add the prefix 'Data Management SPICE® PRM/PAM' to the subject of your ticket.

For a change request to be processed it must contain

a) a detailed problem description,

b) an elaborated argumentation, why a particular rationale is false or incomplete,

c) a change proposal.

0.6 References

[1] ISO/IEC 33001:2015 Information technology -– Process assessment – Concepts and terminology

[2] ISO/IEC 33002:2015 Information technology -– Process assessment – Requirements for performing process assessment

[3] ISO/IEC 33003:2015 Information technology -– Process assessment – Requirements for process measurement frameworks

[4] ISO/IEC 33004:2015 Information technology -– Process assessment – Requirements for process reference, process assessment and maturity models

[5] ISO/IEC 33020:2019 Information technology -– Process assessment – Process measurement framework for assessment of process capability

[6] Automotive SPICE® Process Reference Model/Process Assessment Model, v4.0, VDA QMC[1]

[7] VDA BlueGoldBook 'Automotive SPICE® Guidelines', 2nd. edition, November 2023, VDA, Quality Management in the Automotive Industry

[1] Automotive SPICE® Process Assessment / Reference Model Author(s): VDA QMC Working Group 13 / Automotive SIG Version: 4. Date: 2023-11-29 Status: Released: Public

[8] intacs® certified Provisional Assessor training course materials

[9] intacs® certified Competent Assessor training course materials

[10] DAMA DMBOK 2nd Edition 2017 (Data Management Body of Knowledge)

[11] DAMA Dictionary of Data Management 2nd Edition 2011

[12] ISO 8000-2:2020 (withdrawn)

[13] Data Management Maturity Modell (retired) CMU/SEI-2001-TR-018

[14] ISO/IEC 2382:2015 – Information technology – Vocabulary

[15] ISO/IEC/IEE 24765:2017 – Systems and Software Engineering – Vocabulary

[16] ISO/IEC 20546:2019 – Information technology — Big data — Overview and vocabulary

[17] ISO/IEC 5259-1 —, Artificial intelligence — Data quality for analytics and machine learning (ML) — Part 1: Overview, terminology, and examples

[18] ISO/IEC 22989 — Information technology — Artificial intelligence — Artificial intelligence concepts and terminology

[19] ISO 15288.2:2014 – IEEE Standard for Technical Reviews and Audits on Defense Program[20] ISO/IEC/IEEE 15288:2023 – Systems and software engineering — System life cycle processes

[21] ISO 16439:2014 – Information and documentation — Methods and procedures for assessing the impact of libraries

[22] ISO20000-1:2018 – Information Technology – Service Management

[23] ISO/IEC 22237-1:2021 – Information technology — Data centre facilities and infrastructures — Part 1: General concepts

[24] ISO/IEC 25010:2011 Systems and software engineering - Systems and software Quality Requirements and Evaluation

[25] ISO/IEC/IEEE 29119-1:2013 Software and systems engineering -- Software testing -- Part 1: Concepts and definitions

[26]] ISO/IEC/IEEE 29119-3:2013 Software and systems engineering -- Software testing -- Part 3: Test documentation

[27] IATF 16949:2016-10 Quality management system requirements for automotive production and relevant service parts organisations

[28] ISO IEC IEEE 29148:2018, Second edition 2018-11, Systems and software engineering — Life cycle processes — Requirements engineering

[29] VDA, Volume 6 Part 3, Process Audit, 3rd revised edition, December 2016, revised Feb. 2017

0.7 Terms, definitions, information item characteristics and abbreviations

The glossary was created with the following aspects in mind and applies in context of Data Management SPICE:

- The table covers the terms that are used in purpose/ outcomes/ information items / practices/ notes that fits the existing context and intentions of this PAM for data management.
- The table omits the terms that are already defined in Automotive SPICE® [6].
- ISO standards are used wherever they fit to our purpose in this PAM.
- Own notes are added in case of additional information required for better clarification.

Data Management SPICE follows the following precedence for use of terminology:

- ISO/IEC 33001 for assessment related terminology
- Terms introduced by Automotive SPICE® [6], only selected terms were copied.
- PMBOK® Guide – Fourth Edition – A Guide to the Project Management Body of Knowledge PMBOK® GUIDE Seventh Edition
- Other ISO standards in the domain of managing data

Information item IDs and characteristics

- Information items are listed for each process and mapped to respective outcomes.
- For information items based on Automotive SPICE® [6] see there for their characteristics.
- All data management related information items *[##-DM##]* are defined and characterized as part of the definitions of data management related terms below.

Term	Reference and *Information Item ID*	Description and Information Item Characteristics (IIC)
Approach	intacs working group 'Data Management SPICE' *[08-DM01]*	An approach (CL1) describes high-level activities or actions (the doing part, in ASPICE 4.0 called "measures") and related criteria (e.g., a DoD) to achieve the intended purpose of the data management project (described in the business case) and the purpose of the related process.
Audit	ISO 22716:2007(en), 2.2	An audit is the systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable for achieving objectives. Note: An audit result is a pass or fail with potential non-conformances, which have to be fixed.
Authoritative Source of Data	intacs working group 'Data Management SPICE' *[14-DM04]*	An authoritative source of data is considered as the most reliable and trustworthy source for specific information.
Base Practice (BP)	ISO/IEC 33001:2015, 3.3.2	Activity that, when consistently performed, contributes to achieving a specific process purpose.
Blue Gold Book (BGB)	VDA [7]	Automotive SPICE® Guidelines ('BlueGoldBook')
Business Case	intacs working group 'Data Management SPICE' *[05-DM01]* based on: • A Guide to the Project Management Body of Knowledge PMBOK® GUIDE Seventh Edition AND The Standard for Project Management ANSI/PMI 99-001-2021 • ISO/TR25104:2008 (en), 3.3	A business case contains the intended purpose and overall viability of data management related projects; it justifies the initiation of a project by outlining its potential benefits, costs, risks, and feasibility. It provides decision-makers with the necessary information to determine whether a project is worth pursuing or continuing; it provides a rationale for determining which data management projects should be funded and ensures the sustainability of data management by making decisions based on business considerations and benefits to the organizational unit. It ensures that all relevant stakeholders are aligned and stay aligned on the intended purpose.

Business Glossary	intacs working group 'Data Management SPICE' *[14-DM01]*	A business glossary ensures consistent understanding and usage of data management related terms. It acts as a central repository for definitions of key business terms, promoting clarity and reducing ambiguity. It typically contains business terms and definitions, synonyms and acronyms, as well as the context or examples of usage. Each entry should include a clear, concise, and unambiguous definition. The definitions should be easily understandable by all stakeholders, regardless of their technical expertise.
Business Objective	ISO/IEC/IEE 24765:2017	Strategy designed by senior management to ensure an organization's continued existence and enhance its profitability, market share, and other factors influencing the organization's success.
Capability Level (CL)	Automotive SPICE® PRM/PAM V4.0 Chapter 5	Process capability indicators such as generic practices and information items are the means to support the judgment of the degree of achievement of the associated process attribute. Further explanation can be found in Automotive SPICE® PRM/PAM.
Conceptual Schema	intacs working group 'Data Management SPICE' *[04-DM02]* based on: ISO/TS 19150-1:2012(en), 4.3 and ISO/IEC 11179-3:2023(en), 3.2.33	A conceptual schema is a formal description of an abstract view of the real world. The conceptual schema describes the structure of the whole data, i.e., the elements of data, their relationships and constraints. It is independent of specific technologies for managing and storing the data. Note: in practice some use the term "data model/modelling" instead of conceptual schema.
Data	ISO 8000-2:2020, ISO/IEC 2382:2015 *[03-DM00]* Notes by intacs working group 'Data Management SPICE'	Data is a reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing. Note: Data is a collection of discrete values that convey information, describing quantity, quality, fact, statistics, other basic units of meaning, or simply sequences of symbols that may be further interpreted. Note: "data" in the context of Data Management SPICE implies that you consider the management of any relevant data type, data sets, master data or meta data.

Data Cleansing	ISO 13008:2022, 3.4	Data cleansing is the process used to improve data quality by detecting and correcting (or removing) defects and errors in data.
Data Deployment	intacs working group 'Data Management SPICE'	Data deployment is the transition of data to the operational data management system. Note: data deployment is like an industrialization step before starting production.
Data Flow	intacs working group 'Data Management SPICE' *[03-DM03]*	A data flow specifies the movement of data through the active parts of a data management system to implement an intended purpose. It's the dynamic aspect of data, showing how it moves and changes over time. Data flows consider the volume, velocity, and variety of data based on the scope of data management and typically address: • Demarcation points, • (authoritative) sources of data, • data quality activities, • data storage interfaces, • as well as activities related to data integration, processing, automation, storing etc. (e.g., ETL = Extract Transform Load).
Data Governance	intacs working group 'Data Management SPICE' Based on: ISO 8000-2:2022, 3.16.1	Data governance refers to all mechanisms, assets and policies in place • to ensure data security and protection by addressing related security goals, • to manage access control, and • to ensure compliance with regulatory/legal constraints.
Data Integration	SO/IEC 30145-3:2020, 3.1.7 Note by intacs working group 'Data Management SPICE'	Data Integration is the process of combining data (3.1.1) residing in different sources and providing users with a unified view of them. Note: In the context of Data Management SPICE, data integration refers to the process of migrating, merging, standardizing, replicating or transforming data from one or multiple sources to provide a complete, accurate, and up to date data set. Applicable data integration techniques depend • on the volume, velocity and variety of the data to be integrated.

		• on the characteristics of the sources and destinations of data. • on time and resources available, and • on applicable performance requirements.
Data Integration Techniques	intacs working group 'Data Management SPICE'	Data integration techniques are, e.g.: • Manual data integration: Engineers manually write code that moves and manipulates data based on business needs. • Application-based data integration: Applications are directly linked and move and transform data based on event triggers. • Common data storage: Data is extracted from sources and stored in a data lake or data warehouse providing a single source. • Data virtualization: Data from different sources is combined in a virtual database where end users can access it. • Middleware data integration: Software is used to transfer information between systems.
Data Life Cycle	ISO/IEC 20547-3:2020, 3.12 *[10-DM01]* Note by intacs working group 'Data Management SPICE'	Data life cycles are the stages in the management of a data. Note: A data life cycle represents all the stages through which data can pass within any system that uses data of any kind. It is designed to support the achievement of an intended purpose and usually serves as a constraint for data management processes.
Data Management	intacs working group 'Data Management SPICE' Based on: ISO/IEC/IEEE 24765:2017, 3.1017	Data Management is the set of all processes, approaches, and resources for handling the value of the resource "data" across the data life cycle for an intended purpose for a given scope of an organizational unit.
Data Management System (DMS)	intacs working group 'Data Management SPICE' *[11-DM01]*	The data management system (aka the technical infrastructure) encompasses the underlying hardware and software components that support the operation of IT systems for data deployment and operations. This includes servers, storage devices, networks, databases, platforms, and operating systems. It provides the technical foundation for data management activities.

		Note: the engineering, deployment, and operation of the technical infrastructure itself is out of scope for data management; see SYS/SWE processes for engineering the related service systems, and ITSM for managing the data management system (demand, change, incident, problem management, etc.).
Data Mining	ISO 16439:2014, 3.13	Data mining is a computational process that extracts patterns by analyzing quantitative data from different perspectives and dimensions, categorizing them, and summarizing potential relationships and impacts.
Data Operations	intacs working group 'Data Management SPICE'	Data operations is about managing and monitoring the status of the data management system, the data governance, and the data quality during operations.
Data Owner	intacs working group 'Data Management SPICE' based on: ISO/TR 14872:2019	Data owner refers to an organization that is in the position to obtain, create, and have significant control over the content, access and distribution of data, i.e., the ability to decide who can access and use data and how to protect data. Ownership implies responsibility for accuracy, integrity, and security of data.
Data Profiling	intacs working group 'Data Management SPICE'	Data profiling is the process of examining and analyzing existing data sources to gather statistics and insights. This process aids in understanding the data's content, structure, and quality.
Data Quality	ISO 8000-2:2022, 3.8.1 Note by intacs working group 'Data Management SPICE'	Data quality is the degree to which a set of inherent characteristics of data fulfils requirements. Note: Data quality is a qualitative or quantitative measurement of the degree to which data fulfils specified criteria, rules, and thresholds (e.g., related to accuracy, completeness, consistency, timeliness, validity). Data quality is the key to achieving the intended purpose.
Data Quality Activities, Criteria, Rules and Thresholds	intacs working group 'Data Management SPICE' *[03-DM06]*	The phrase "data quality activities, criteria, rules and thresholds" refers to the structured approach an organizational unit takes to ensure its data is fit for purposes: • Data quality activities encompass the entire life cycle of data. • Data quality criteria are the broader attributes or dimensions used to evaluate and define what constitutes "good data quality".

		• Data quality rules are specific, logical expressions or conditions that data must satisfy to be considered high quality. They define the expected or acceptable values, formats, ranges, patterns, or relationships of data elements. • Data quality thresholds are numerical values or percentages that represent the minimum acceptable degree of quality for a given data quality metric or the maximum allowable number of data quality issues. When these thresholds are breached, measures are triggered. Note: Activities are the actions taken, rules are the specific conditions data must meet, criteria are the dimensions of quality being measured, and thresholds are the acceptable limits for those measurements, triggering attention when crossed.
Data Set	ISO 8000-2:2020 *[03-DM01]*	A data set is a logically meaningful grouping of data.
Data Types	intacs working group 'Data Management SPICE' *[03-DM05]*	Depending on the usage scenario, data types cover • Business critical data like customer, product, financial, and operational data, • Personally identifiable and healthcare information (e.g., regulated via privacy act like GDPR), • Analytical data like data on sales, marketing, performance, • Meta data and information on data quality, and • Any kind of relevant unstructured data (e.g,. text, multimedia, logs). Note: By carefully identifying relevant data types, you can build a robust business case and define a clear scope of the data management project (see also MAN.3 BP.1)
Demarcation Point	ISO/IEC 22237-1:2021, 3.1.10 *[14-DM02]*	A demarcation point is the point where the operational control or ownership changes. Note: Demarcation points are needed to identify and handle a change of data owners.

	Note by intacs working group 'Data Management SPICE'	
Development / Supplier Interface Agreements (DIA/SIA)	ISO26262-1:2018, 3.32	A development or supplier interface agreement (DIA / SIA) is an agreement between customer and supplier in which the responsibilities for activities to be performed, evidence to be reviewed, or work products to be exchanged by each party related to the development of items or elements are specified.
Generic Practice (GP)	ISO/IEC 33001:2015, 3.3.6	Generic practice is the activity that, when consistently performed, contributes to the achievement of a specified process attribute.
Information Item (II)	ISO/IEC 33001:2015, 3.1.4, and ISO/IEC 33004:2015, 6.3.1 Automotive SPICE® PRM/PAM V4.0, §3.3.2.1, §3.3.1	Separately identifiable body of information that is produced, stored, and delivered for human use. Information items are defining relevant pieces of information used by the assessors to judge the achievement of process attributes. […] Information items (together with their characteristics) are provided as guidance for "what to look for" when examining the work products available in the assessed organization. The extent of implementation of an information item […] serves as objective evidence supporting the assessment of a particular process.
Information Item Characteristics (IIC)	Automotive SPICE® PRM/PAM V4.0 Annex B Information Item Characteristics Automotive SPICE® PRM/PAM V4.0, §3.3.2.1, §3.3.1	Information item characteristics (IIC) provide examples of the potential characteristics associated with the information item types. The assessor may use these in evaluating the samples provided by the organizational unit. It is not intended to use the characteristics described as a checklist. Some characteristics may be contained in other work products, as it would be found appropriate in the assessed organization. Information item characteristics should be considered as indicators when considering whether, given the context, a work product is contributing to the intended purpose of the process. Context-sensitivity means that assessor judgment is needed to ensure that the actual context (application domain, business purpose, development methodology, size of the organization, etc.) is considered when using the information items.

	Note by intacs working group 'Data Management SPICE'	Note: for the Data Management SPICE PAM there will be no additional IIC beyond the definitions in this glossary. The quality attributes are not treated separately but are directly embedded in the description of the relevant information items.
Intended Purpose	intacs working group 'Data Management SPICE'	The intended purpose is used in building and operating specific services related to data. It is the primary reason for which a data management project was initiated, and it drives the specification of requirements, the expected data quality, the creation of a data life cycle and flow, the building and operating of the required data management system. Important note: The intended purpose can vary depending on its usage scenario. It is essential that all data management related activities are performed with their intended purpose in mind to ensure data governance and to perform their function effectively. Failure to consider the intended purpose can result in costly problems, vulnerabilities, safety hazards, and reduced functionality.
Key Performance Indicator (KPI)	ISO/TS 22386:2024, 3.1.11	Key Performance Indicator (KPI) is a quantifiable measure that an organization uses to gauge or compare performance in terms of meeting its strategic and operational objectives.
Metadata / Meta Data	ISO/IEC 25024:2015,4.29 *[03-DM02]* Note based on Data Management Maturity Model Version 1.0 August 2014 (p. 58) [13]	Metadata / meta data is the data that defines and describes other data. Note: In the context of Data Management SPICE, metadata is a category of information that identifies, describes, explains, and provides content, context, structure, and classifications pertaining to an organization's data assets and enables effective retrieval, usage, and management of these assets.
Operating Environment	intacs working group 'Data Management SPICE'	The operating environment is defined as the system in which the data is processed (e.g., hardware, operating system etc.). See also data management system.
Operational Concepts and Scenarios	intacs working group 'Data Management SPICE' *[17-DM03]* based on:	Operational concepts and scenarios describe the interaction of the data platforms and their interfaces with the environment, operators, and (end) users. They typically cover the full life cycle of data both before and during operations.

	• ISO/TR 16158:2021 (en), 3.8 • ISO/IEC/IEEE 24765:2017(en), 3.2713 • ISO/IEC/IEEE 29148:2011, 4.1.15	An operational concept and scenario is designed to give an overall picture of data operations from different stakeholder perspectives. They are used to make explicit some of the functional or non-functional (quality attribute) needs of the stakeholders
Organizational Unit ("project")	intacs working group 'Data Management SPICE'	An organizational unit could be a whole organization, a program, a product or service, a project or an initiative within that organization which applies data management practices. The organizational unit is typically the result of scoping, e.g., as part of planning for an assessment. However, the model is typically applied in the context of a customer "project". Hence, the term "project" is still used in the practices of this model instead of the more generic term "organizational unit".
Process Assessment	ISO/IEC 33001:2015, 3.2.15	Process assessment is the disciplined evaluation of an organizational unit's processes against a process assessment model. Note: Process assessment results are qualified outcomes of the assessed entity on a predefined scale.
Process Assessment Model (PAM)	ISO/IEC 33001:2015, 3.3.9	Process assessment model is the model suitable for the purpose of assessing a specified process quality characteristic, based on one or more process reference models.
Process Attribute (PA)	ISO/IEC 33020:2019, Clause 5.1	Process attribute defines a measurable property of process capability. The extent of process attribute achievement is characterized on a defined rating scale. The process capability level for an assessed process is derived from the set of process attribute ratings represented in the process profile.
Process Performance Strategy	Automotive SPICE® PRM/PAM V4.0– 19-01	• The operational approach to achieve the process outcomes, consistent with the Process Performance Objectives (18-58), e.g.: - proceedings, including the monitoring of the performance of the process - methodology. • Scope(s) of the strategy within the process, e.g.:

		- development site– application domain-specific differences (e.g., software drivers versus. powertrain software) - disciplines (e.g., different configuration management approaches for software and hardware, or combined approaches) - options due to socio-cultural differences.
Process Reference Model (PRM)	ISO/IEC 33001:2015, 3.3.16	Process reference model is the model comprising definitions of processes in a domain of application described in terms of process purpose and outcomes, together with an architecture describing the relationships between the processes.
Requirements for Data Management	intacs working group 'Data Management SPICE' *[17-DM01]*	(Derived) requirements for data management typically address the following categories for the relevant data types: • Data flow and data life cycle • Data acquisition/sources • Data management systems • Data deployment and operations • Data governance
Requirements for Data Quality	intacs working group 'Data Management SPICE' *[17-DM02]*	Requirements for data quality specify the expected data quality and are used to derive respective data quality activities, criteria, rules, and thresholds to achieve an intended purpose.
Scope of Data Management	intacs working group 'Data Management SPICE' *[03-DM04]*	The scope of data management encompasses • an identification of key data types to be managed, • an initial understanding of available data sources, • an early estimate of the expected volume, velocity, and variety of data, and • identified constraints on data governance.
Security Goals	intacs working group 'Data Management SPICE' *[14-DM03]*	Security goals encompass confidentiality, integrity, and availability (i.e., CIA triad) as well as authenticity, authorization, and non-repudiation of data across the life cycle (e.g., for data collection, processing, storage, and transmission/delivery). Data security and protection are achieved by addressing these security goals.

Service Level Agreement (SLA)	ISO20000-1:2018, 3.2 – 3.2.20	A service level agreement (SLA) is a documented agreement between the organization and the customer that identifies services and their agreed performance.
Systems Process Improvement and Capability dEtermination (SPICE)	Automotive SPICE® PRM/PAM V4.0 Chapter 1.1	The Automotive SPICE process assessment model (PAM) is intended for use when performing conformant assessments of the process capability on the development of embedded automotive systems. It was developed in accordance with the requirements of ISO/IEC 33004:2015/2019.
Technical Concept	intacs working group 'Data Management SPICE' *[04-DM01]*	The technical concept is the high-level design for how data is (going to be) managed in a data management system. It describes on a high level the required elements for data storage, data processing, and data retrieval. Respective requirements are allocated to elements of the technical concept. Notes: • The technical concept typically emerges together with the data flow. It provides the framework within which the data flow operates. The data flow provides input related to the volume, velocity, and variety of data based on the data management scope. • The technical concept drives the design and solutions for the data flow, conceptual schema, sources of data, as well as concepts to ensure data governance.
Usage Scenario	intacs working group 'Data Management SPICE'	A usage scenario provides examples on how data is used, e.g., for data warehousing, data analytics, machine learning models, data lakes, or specific data for a customer, product, service, or internal use.

Table 1: Specific and generic terminology for data management including information item characteristics

1. Introduction

In today's world, data has become one of the most valuable assets of any organization. Whether it is about customer information, financial records, or internal documents, data plays a critical role in decision-making, strategy development, and overall business success. However, the increasing volume, complexity, and diversity of data have made it difficult for organizations to manage their data effectively. This is where good data management processes come into play.

Good data management processes are the systematic and structured approaches that organizations use to manage their data throughout their life cycle, from creation to disposal. These processes ensure that data is accurate, consistent, and reliable, and is easily accessible to the people who need it.

There are several reasons why good data management processes are important. Firstly, they help organizations make informed decisions by providing accurate and timely information. Secondly, they ensure that data is secure and compliant with legal and regulatory requirements. Thirdly, they improve efficiency by reducing duplication, errors, and inconsistencies. Finally, they enable collaboration and knowledge sharing by making data easily accessible to employees, partners, and customers.

In summary, good data management processes are essential for any organization that wants to leverage data for business success. By implementing these processes, organizations can ensure that their data is accurate, secure, and accessible, which can lead to better decision-making, improved efficiency, and a competitive advantage in the marketplace.

Over the past years, more and more development projects have been embracing the Data Management principles for their work.

The Automotive SPICE® process reference model and process assessment model, however, do not explicitly address these new needs. This leads to diverging interpretation both among assessors and improvement teams.

This document supports the application and evaluation of the Data Management practices during assessment and improvement projects, both as standalone process model and as extension to Automotive SPICE®.

Data Management SPICE contains both the complete process dimension in chapter 2 as well as the process capability dimension in chapter 3.

Data Management SPICE addresses five data management specific processes and 9 referenced processes, all up to capability level 5. The process attributes and indicators are based on the generic practices from Automotive SPICE® and described in chapter 3.

Annex A confirms the conformance to the ISO 33000 series.

Annex B addresses Data Management SPICE interpretation guidance of reference processes of Automotive SPICE® PRM/PAM.

Annex C provides information on interfaces to other relevant models and standards.

Annex D talks about responsibilities of senior management to ensure persistence and habit.

1.1 Purpose

The purpose of this document is to provide a comprehensive body of knowledge for Data Management process improvement capability determinations inspired by the Automotive SPICE® PRM/PAM approach but not limited to automotive applications. The document defines a PRM and PAM for Data Management assessment and improvement, based on two process groups with a total of five processes dedicated to data management as well as 9 referenced processes.

The core of Data Management SPICE is the Process Assessment Model (PAM) including processes from the Process Reference Model (PRM) to provide a structured approach to evaluating organizational units' data management processes.

The practices enable organizations to identify gaps between the model and their implemented approach for data management. This includes identifying potential inefficiencies in an organization's data management and recommending improvements that will help an organizational unit to optimize its data management capabilities.

Process attributes and indicators are used to achieve capability levels 0 to 5, see chapter 3.

By using a Data Management Process Assessment Model, organizations can:

- Increase the likeliness of accurate, complete and consistent data.
- Improve operational efficiency.
- Reduce risks associated with non-compliance and regulatory violations, e.g. GDPR.
- Gain a better understanding of how content and value is created based on data.
- Provide measures and criteria to better understand and improve data quality throughout the data life cycle.

In summary, the purpose of a Data Management Process Assessment Model is to provide organizational units with a structured and systematic approach to evaluating and improving their data management practices, potentially resulting in increased data quality, data security, compliance, and operational efficiency as well as related data governance.

1.2 Process Reference and Assessment Model

Process Reference Model

Processes are collected into process groups according to the domain of activities they address. These process groups are organized into 3 process categories: Primary life cycle processes, Organizational life cycle processes and Supporting life cycle processes.
For each process a purpose statement is formulated that contains the unique functional objectives of the process when performed in a particular environment. For each purpose statement a list of specific outcomes is associated, as a list of expected positive results of the process performance.
For the process dimension, the Data Management SPICE process reference model provides the set of processes shown in Figure 1.

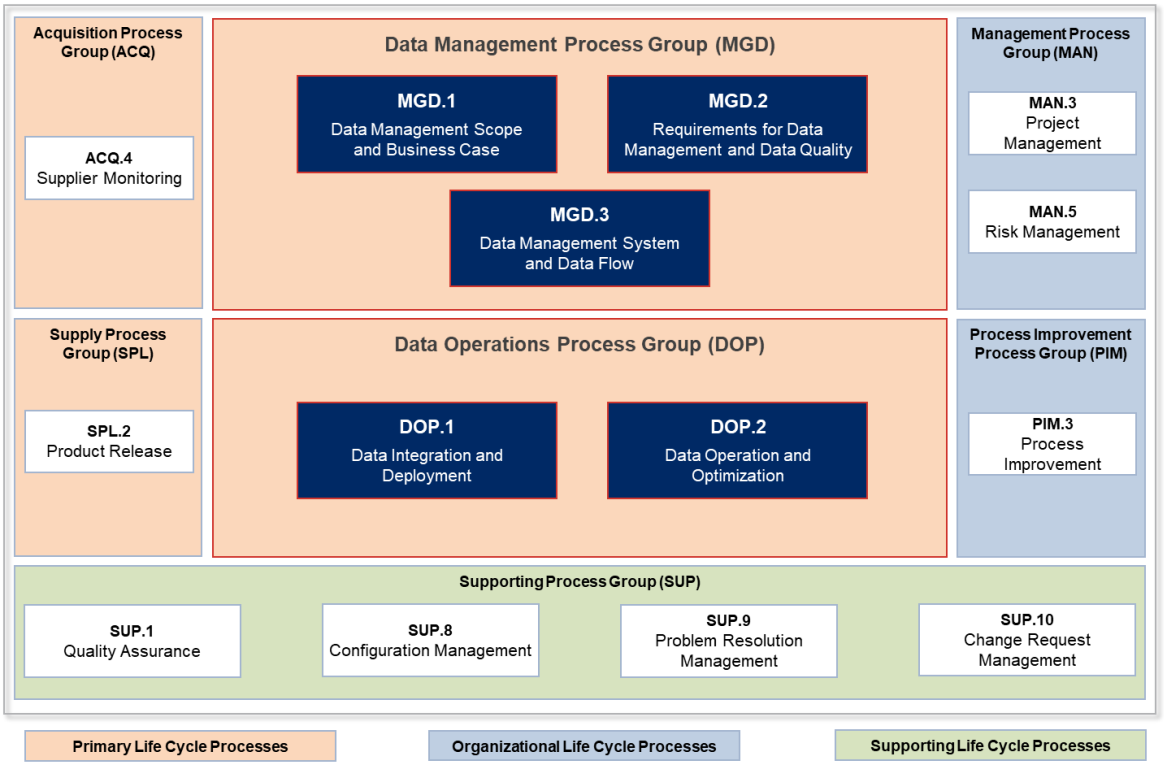

Figure 1: Data Management SPICE process reference model - overview

The data management processes (MGD/DOP) for capability level 1 are described in chapter 2.
The following processes are used to anchor data management in the respective organizational unit and are just referred to; details can be found in Automotive SPICE® [6]:

- MAN.3 Project Management
- MAN.5 Risk Management
- ACQ.4 Supplier Monitoring
- SUP.1 Quality Assurance
- SUP.8 Configuration Management
- SUP.9 Problem Resolution Management
- SUP.10 Change Request Management
- SPL.2 Product Release
- PIM.3 Process Improvement

Process Assessment Model

The process assessment model offers indicators in order to identify whether the process outcomes and the process attribute outcomes (achievements) are present or absent in the instantiated processes of organizational units. These indicators provide guidance for assessors in accumulating the necessary objective evidence to support judgments of capability; see Automotive SPICE® [6] in §3.3 for more explanations on the measurement framework and different types of indicators.

Usage

This model can be used standalone for the assessment of process capability of data management including the referenced processes from Automotive SPICE®. It also can be combined with any other SPICE model depending on organizational unit, business need, and usage scenario. Typical combinations are with Automotive SPICE® or SPICE for IT-Services.

The 'Automotive SPICE® Guidelines' and their support for assessment scoping, rating practice, rating text patterns, and rating rules apply to this document as is.

1.3 Scope

Data Management SPICE includes practices to assess and stipulate improvements of data related processes and process performance. Practices can range from defining a business case, eliciting data management and data quality requirements, designing the data model, data flow and technical infrastructure, managing (trusted) data sources and ownership, to practices for using and operating data and metadata to achieve an intended purpose.

Typically, an organizational unit like a data management project, a program, a whole product platform or an initiative is in scope.

Areas of application (usage scenarios)

The Data Management Process Assessment Model can be applied to any area where data is managed for an intended business case. Examples for data usage include, but are not limited to:

- Government: e.g., for trend analysis of age of inhabitants, number of inhabitants, rural-urban migration, single families.
- Non-profit, NGO: e.g., for membership administration, environmental data analysis (air / water pollution).
- Automotive: e.g., for autonomous driving, mobile online services, customer care
- Mobility: e.g., for telematics data, traffic flow management, toll data, vehicle identification, road safety and road user analyses
- Health: e.g., for administration of patient and e-patient records, diagnostic pattern recognition
- e-Commerce: e.g., for use of customer data, targeted advertising
- Finance: e.g., for trend analyses on the capital market, consumer credit rating
- Insurance: e.g., for handling risk data
- Meteorology: e.g., for weather and climate data, forecasting for open-air events, shipping, construction sites, production, daylight mining
- Security: e.g., for surveillance based on video systems.

2. Data management process dimension: reference processes & performance indicators (CL1) & rating rules

Editorial guidance

The processes in the process dimension can be drawn from the PRM, which is incorporated in the tables below indicated by a red bar at the left side.

Analogously to Automotive SPICE®, each table related to one process in the process dimension contains the PRM and the process performance indicators necessary to define the PAM. The process performance indicators consist of base practices (indicated by a green bar) and information items (indicated by a blue bar).

Note that if an information item given here does not appear in the glossary, it represents the corresponding one in Automotive SPICE® [6]. Rating rules can be applied based on the VDA guidelines and as described per process in this PAM.

The processes in the process dimension can be drawn from the Automotive SPICE process reference model, which is incorporated in the tables below indicated by a red bar at the left side.

2.1 Managing Data process group (MGD)

2.1.1 MGD.1 Data management scope and business case

Process ID	**MGD.1**
Process name	**Data management scope and business case**
Process purpose	The purpose is to identify the scope of data management, manage stakeholders, and specify and align the business case and glossary to achieve the intended purpose.
Process outcomes	As a result of successful implementation of this process: 1) The scope of data management, constraints on data governance, and types of data to be managed are identified. 2) Stakeholders for data management are identified, analyzed, and their involvement is managed. 3) A business case is specified, aligned, and communicated to achieve an intended purpose. 4) A business glossary is specified, aligned, and communicated for all data management-related terms.

Base practices	**MGD.1.BP1: Identify scope, data governance, and data types.** Identify and record the scope of data management, constraints by data governance, and the types of data to be managed. *NOTE 1: The data management scope clearly outlines what is included and what is not included.* *NOTE 2: Typically, the scope and constraints are recorded as part of the business case.* *NOTE 3: This practice expands MAN.3.BP1 for data management related scoping.* **MGD.1.BP2: Identify and manage stakeholders.** Identify internal and external stakeholders. Analyze and manage their involvement and potential conflicts. *NOTE 4: The list of stakeholders is created based on the data management scope, the usage scenario, and on active identification and involvement of relevant internal and external parties.* *NOTE 5: Managing stakeholders typically covers the whole data life cycle as well as the creation and operation of the data management system.* *NOTE 6: Typically, the stakeholder involvement is planned and managed in a communication plan including meeting and reporting schedules and a way to track dependencies and feedback; see also MAN.3.BP7.*

MGD.1.BP3: Specify and align business case.

Specify a business case to justify and outline potential benefits, costs, risks, and feasibility of a data management project to achieve an intended purpose. Ensure alignment of intended purpose among stakeholders and communicate the result.

NOTE 7: Understanding the scope of data management (the what) and creating a business case (the why) is typically an iterative and interconnected activity.

NOTE 8: Both scope and business case help in achieving a shared understanding among stakeholders and help managing expectations and preventing conflicts. Both serve as reference point for evaluating change requests and as a guide for making decisions.

NOTE 9: The anticipated benefits and costs should be specific, measurable, and linked to data management and data quality expectations.

NOTE 10: Typically, constraints by data governance and availability of data or data sources significantly impact the feasibility of a business case.

NOTE 11: Analyze if an existing business case can be reused or needs to be adapted. If reuse is applied, analyze whether current requirements are complete, correct, and comprehensive.

MGD.1.BP4: Specify and align business glossary.

Specify and keep up to date a business glossary for all data management-related terms. Ensure alignment of the business glossary among stakeholders and communicate the result.

NOTE 12: The glossary typically grows and needs to be updated throughout the specification and implementation and operation of data management activities.

NOTE 13: Ensure unique name and description of terminology.

NOTE 14: Ensure that terms from the glossary are applied consistently.

MGD.1 **Data management scope and business case**	Outcome 1	Outcome 2	Outcome 3	Outcome 4						
Output information items										
03-DM00 Data	X			X						
03-DM04 Scope of management	X									
14-DM03 Security goals	X									
18-00 Standard	X									
03-DM05 Data types	X									
14-50 Stakeholder group list		X								
05-DM01 Business case			X							
02-01 Commitment / agreement			X	X						
14-02 Corrective Action			X							
13-19 Review record	X		X	X						
14-DM01 Business glossary				X						
13-52 Communication evidence		X								
Base Practices										
BP1: Identify scope, data governance, and data types.	X									
BP2: Identify and manage stakeholders.		X								
BP3: Specify and align business case.			X							
BP4: Specify and align business glossary.				X						

MGD.1 – Rating rules	
Rating rules within the process	
[MGD.1.RL.1]	If the scope of data management is contained or distributed across multiple records like business case, operational concepts and scenarios, project/program charter, or program description, then MGD.1.BP1 shall not be downrated.
Rating rules with other processes at level 1	
[MGD.1.RL.2]	If the scope of data management is not clearly specified, e.g., in business case, description of organizational unit, separate document, or project/program charter, then MAN.3.BP1 shall be downrated.
[MGD.1.RL.3]	If the business case and scope of data management are not used to make critical decisions within the organizational unit, e.g., related change requests (SUP.10), prioritizing requirements (MGD.2), making technical decisions (MGD.3), or monitoring operations to achieve the intended purpose (DOP.2), then MGD.1.BP3 shall be downrated.
[MGD.1.RL.4]	If terminology regarding data management is not consistently used for requirements (MGD.2), data flow and data management system (MGD.3), or operations (DOP.2) and has negative impact on data management activities, then MGD.1.BP4 shall be downrated.
[MGD.1.RL.5]	If the stakeholder involvement or a communication plan including meeting and reporting schedules are missing, the indicator MAN.3.BP7 shall be downrated.

2.1.2 MGD.2 Requirements for data management and data quality

Process ID	**MGD.2**
Process name	**Requirements for data management and data quality**
Process purpose	The purpose is to elicit, derive, and manage evolving stakeholder needs and requirements throughout the life cycle of the data. Managing the requirements supports consistency of both content and quality of data across the data life cycle.
Process outcomes	As a result of successful implementation of this process: 1) Operational concepts and scenarios are specified. 2) Stakeholder requirements are elicited and agreed on. 3) Functional and non-functional requirements for data management and data quality are specified. 4) Requirements are evaluated against specified criteria and validated. 5) Consistency and traceability are established between stakeholder and derived requirements. 6) Requirements are communicated to all affected parties including changes. 7) Requirements are aligned with the scope of data management and the intended purpose.

Base practices	**MGD.2.BP1: Specify operational concepts and scenarios.** Involve relevant parties to specify operational concepts and scenarios. Use the operational concepts and scenarios to elicit and initiate the refinement of functional and non-functional stakeholder needs related to data management. *NOTE 1: The stakeholders involved should be clearly defined (see also MGD.1.BP2).* *NOTE 2: Consider covering the whole data life cycle (e.g., Create, Process, Share/Use, Store/Retain/Archive, Delete) in the operational concepts and scenarios.* *NOTE 3: Non-functional needs typically address data governance constraints.* **MGD.2.BP2: Elicit stakeholder requirements.** Elicit stakeholder requirements from stakeholder needs. Ensure common understanding and agreement on stakeholder requirements. *NOTE 4: Typically, stakeholder requirements address business, legal, normative, safety and security requirements (i.e., related to data governance, see MGD.1.BP1) as well as internal requirements and specific customer requirements to achieve an intended purpose. They are usually documented in a formal or structured way.* *NOTE 5: Stakeholder requirements typically describe the problem space and not the (anticipated) solution space.*

MGD.2.BP3: Derive requirements.

Derive and specify functional and non-functional requirements for data management and data quality.

NOTE 6: Sources of derived requirements are stakeholder requirements and should consider operational concepts and scenarios, the intended purpose, and related approaches.

NOTE 7: Typically, derived requirements for data management and data quality cover:

- *data quality,*
- *data acquisition/sources,*
- *data management system and data flow*
- *data deployment and operations, and*
- *data governance.*

NOTE 8: The usage scenarios for data management drive the needed levels of decomposition, processes in focus, and needed categories of derived requirements. The related decisions are typically made based on the intended purpose (MGD.1.BP3), the stakeholder requirements, and the scope (MAN.3.BP1, MGD.1.BP1).

MGD.2.BP4: Analyze and validate requirements.

Specify and use activities and criteria for the analysis and validation of requirements.

NOTE 9: Measures for analysis are typically performed by formal and content-related reviews by subject matter experts based on defined criteria:

- *Typical criteria for individual requirements include but are not limited to correct, comprehensible/understandable, atomic, implementation free, unambiguous, verifiable.*
- *Typical criteria for individual and sets of requirements include but are not limited to necessary, complete, consistent, feasible, verifiable, traceable, correct terminology in line with the business glossary, and coverage of whole data life cycle.*

NOTE 10: Measures for validation could be reviews by stakeholders or provided mock-up/ exemplary data sets based on respective requirements to ensure achieving a common understanding of requirements and their feasibility.

NOTE 11: Analyze the impact of derived requirements on related data management activities and on the (potential) data management system.

MGD.2.BP5: Ensure consistency and establish traceability.

Ensure consistency and establish traceability between derived requirements and stakeholder requirements.

NOTE 12: Consider all related outcomes for consistency and alignment, e.g., with operational concepts and scenarios and with business case.

NOTE 13: The criticality and risks of stakeholder requirements (e.g., related to functional safety or security) drive the need for the level of detail of traceability to lower levels.

MGD.2.BP6: Communicate requirements.

Communicate agreed stakeholder and derived requirements to all affected parties including agreed changes of requirements. Ensure alignment to scope of data management and intended purpose.

NOTE 14: Typically, baselines are used for agreed on sets of requirements as basis for communication and alignment (see SUP.8).

NOTE 15: Typically, requirements and targets related to data quality need constant alignment among stakeholders.

NOTE 16: Use and update the business glossary.

MGD.2 **Requirements for data management and data quality**	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7			
Output information items										
17-DM03 Operational concepts and scenarios	X									
17-00 Requirement		X	X							
17-DM01 Requirements for data management			X							
17-DM02 Requirements for data quality			X							
17-54 Requirement attribute				X						
15-51 Analysis results				X						
13-51 Consistency evidence					X					
13-52 Communication evidence						X				
13-19 Review record							X			
Base Practices										
BP1: Specify operational concepts and scenarios.	X									
BP2: Elicit stakeholder requirements.		X								
BP3: Derive requirements.			X							
BP4: Analyze and validate requirements.				X						
BP5: Ensure consistency and establish traceability.					X					
BP6: Communicate and align requirements.						X	X			

MGD.2 – Rating rules	
Rating rules within the process	
[MGD.2.RL.1]	If selected sets of data management requirements are not derived from operational concepts and scenarios but from stakeholder requirements which do not affect the operational concepts and scenarios, then MGD.2.BP3 shall not be downrated.
[MGD.2.RL.2]	If the analysis results of requirements are not demonstrated by means of separate analysis reports or review records but by means of e.g. tool - supported attributes or tool-supported commenting, then MGD.2.BP4 shall not be downrated.

2.1.3 MGD.3 Data management system and data flows

Process ID	**MGD.3**
Process name	**Data management system and data flows**
Process purpose	The purpose is to specify the data management system and to design the data flows based on respective requirements.
Process outcomes	As a result of successful implementation of this process: 1) A technical concept for the data management system is specified and maintained. 2) Data life cycle and data flows are identified and maintained. 3) Sources of data are identified and maintained as well as their characteristics. 4) Criteria for authoritative sources of data are defined. 5) Demarcation points are identified and maintained. 6) Quality activities, criteria, rules, and thresholds are specified. 7) Conceptual schemes of data are specified and maintained. 8) Consistency and traceability are established among the derived requirements, the technical concept, and the data flows. 9) The technical concept and data flows are communicated and aligned to the intended purpose.

Base practices	**MGD.3.BP1: Specify technical concept.** Specify and keep up to date a technical concept for the data management system as basis for selecting technical solutions and for make-or-buy decisions. *NOTE 1: The technical concept forms the basis for make-or-buy decisions, selecting technical solutions, and for how to monitor the data management system for effectiveness and efficiency e.g., via SLA.* *NOTE 2: The technical concept should cover applicable data governance constraints.* *NOTE 3: Typically, there is a strong connection and interdependency between the technical concept and considerations regarding data flow, data sources, authoritative sources of data, and demarcation points.* **MGD.3.BP2: Specify data flows.** Identify and keep up to date the data flows considering respective requirements, the technical concept and the data life cycle to achieve the intended purpose. *NOTE 4: Data flows allow to validate the estimates for volume, velocity, and variety contained in the* scope of *data management.* *NOTE 5: Designing data flows typically creates further requirements like latency, transmission capacity, and buffer capacity.*

MGD.3.BP3: Specify sources of data.

Specify needed characteristics for sources of data. Identify, select, and keep up to date sources of data across the data flows based on specified selection criteria.

NOTE 6: Typical characteristics of data sources include name of the source, exchange format, expected/actual data quality, owner, etc.

NOTE 7: Consider traceability from sources through processing to usage based on intended purpose.

NOTE 8: Multiple data sources are evaluated against the specified selection criteria and prioritized in alignment with data quality activities, criteria, rules and thresholds (see MGD.3.BP6).

NOTE 9: Selection criteria typically reflect stakeholder requirements like business, quality, legal, normative, safety, and security requirements derived form data governance constraints.

MGD.3.BP4: Define authoritative sources of data.

Define criteria to identify authoritative sources of data and mark the authoritative sources of data across the data flows.

NOTE 10: Define and use selection criteria to designate authoritative data sources, e.g., based on characteristics like origin, accuracy and reliability, timeliness/freshness, completeness, consistency, legal mandate, accountability and ownership, risks from data security/protection.

NOTE 11: In the case that two or more sources indicate mismatching data: consider the data estimated as the most reliable one according to the intended purpose and defined criteria.

MGD.3.BP5: Specify demarcation points.

Identify and keep up to date demarcation points across the data flows.

NOTE 12: Candidates for demarcation points should be identified, e.g., per merge/split of data, per explicit change of ownership/responsibility internally (e.g., processing in another country) or externally, per platform change or new data flow.

NOTE 13: In case of shared data or multiple users of the same data, ensure that clear responsibilities and change control mechanisms are agreed on (see SUP.10).

NOTE 14: Consider data governance aspects at each demarcation point.

MGD.3.BP6: Specify data quality.

Specify data quality activities, criteria, rules and thresholds across the data flows and the complete life cycle of the data.

NOTE 15: Typically, data quality depends on the domain of data and related business: e.g., accuracy, completeness, consistency, credibility, correctness, accessibility, compliance, confidentiality, efficiency, precision, traceability, understandability, availability, portability, recoverability [see ISO/IEC 25012]

NOTE 16: The criteria and thresholds are recorded to ensure that the data achieves its intended purpose during deployment and operations.

NOTE 17: Consider the influence and impact of data bias as quality criterion across the data flows (especially in context of machine learning).

MGD.3.BP7: Specify conceptual schema.

Specify the structure and elements of data as well as their relationships and constraints across the data flows in a conceptual schema.

NOTE 19: The structure of data typically describes the schema or design that dictates how data is stored and accessed.

NOTE 20: The elements of data typically describe the smallest, individual, and meaningful units of data within a larger data structure. These are often referred to as fields, attributes, or columns.

NOTE 21: The constraints typically describe restrictions applied to data elements or relationships to ensure data integrity, consistency, and validity (e.g., not null constraint, uniqueness, conditions).

MGD.3.BP8: Ensure consistency and establish traceability.

Ensure consistency and establish traceability between derived requirements, the technical concept, and the data flows.

NOTE 22: Ensure consistent use and implementation of the business glossary as basis for consistency.

MGD.3.BP9: Communicate and align results.

Communicate the technical concept and the data flows to affected parties. Ensure alignment of both to the intended purpose.

MGD.3 **Data management system and data flows**	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7	Outcome 8	Outcome 9	
Output information items										
04-DM01 Technical concept	X									
03-DM03 Data flow		X								
10-DM01 Data life cycle		X								
14-DM04 Authoritative sources of data			X	X						
14-DM02 Demarcation point					X					
03-DM06 Data quality activities, criteria, rules and thresholds						X				
04-DM02 Conceptual schema							X			
13-19 Review record	X	X					X			
13-51 Consistency evidence								X		
13-52 Communication evidence									X	
Base Practices										
BP1: Specify technical concept.	X									
BP2: Specify data flows.		X								
BP3: Specify sources of data.			X							
BP4: Define authoritative sources of data.				X						
BP5: Specify demarcation points.					X					
BP6: Specify data quality.						X				
BP7: Specify conceptual schema.							X			
BP8: Ensure consistency and establish traceability.								X		
BP9: Communicate and align results.									X	

MGD.3 – Rating rules	
Rating rules within the process	
[MGD.3.RL.1]	If the technical concept neither covers the data governance constraints nor refers to separate evidence thereof, then MGD.3.BP1 shall be downrated.

2.2 Data Operations process group (DOP)

2.2.1 DOP.1 Data integration and deployment

Process ID	**DOP.1**
Process name	**Data integration and deployment**
Process purpose	The purpose is to prepare data and the data management system for transitioning to operations. The process ensures the readiness of the data management system, data flows, data quality and data governance based on the respective requirements.
Process outcomes	As a result of successful implementation of this process: 1) Data integration and deployment approach is specified to prepare for operations. 2) Data quality activities, criteria, rules, and thresholds are selected for data deployment. 3) Data is integrated, verified, and validated based on data integration approach. 4) Data quality activities, criteria, rules, and thresholds are applied during data integration and deployment. 5) Results and potential impacts on data management and data quality are communicated to relevant stakeholders. 6) Stakeholders are prepared for data operations. 7) Data is deployed based on data deployment approach and the readiness of the data management system 8) Deployment results are recorded and communicated to relevant stakeholders and problems are resolved.

Base practices	**DOP.1.BP1: Specify data integration and deployment approach.** Specify a data deployment and data integration approach to prepare for data operations. *NOTE 1: The approach should define entry and exit criteria from moving from one stage to another. Typically, the approach addresses multiple stages/systems used for e.g., development, deployment, and operations (see SPL.2 for release mechanisms and SUP.8 for baselining).* *NOTE 2: The approach should specify clear responsibility for managing the deployment. Clearly define at which point the accountability shifts from deployment to operations and how the handover is managed.* *NOTE 3: The approach should address all aspects of planning, communicating, managing, and confirming that data effectively makes the transition to the operational environment. It typically includes integration, verification, and validation activities in line with respective requirements.* *NOTE 4: The approach should consider mechanisms for backup, recovery, and archiving data before and after deployment (see also SUP.8).* *NOTE 5: Consider consistency and traceability between derived requirements, technical concept and data flow, and the data deployment and data integration approach.* **DOP.1.BP2: Select data quality activities and criteria.** Select data quality activities, criteria, rules and thresholds to understand and improve data quality during data integration and data deployment. *NOTE 6: Typically, the selection is recorded as part of the approach.* *NOTE 7: Typically, different activities and methods for understanding and improving data quality are selected for different stages and points in time. The sum of all selected activities and methods should allow the organizational unit to monitor and achieve the intended data quality.* **DOP.1.BP3: Integrate, verify, and validate data.** Integrate and verify data based on the data integration approach and ensure the validity of data. *NOTE 8: Integrate, verify, and validate data as specified in the data deployment and integration approach to ensure consistency across deployment. Results are documented and communicated.* *NOTE 9: Typically, selected data quality activities and criteria are used as entry and exit criteria.* *NOTE 10: Consider the influence and impact of data bias as part of integration, verification and validation of data (especially in context of machine learning).* *NOTE 11: Ensure that mechanisms for backup, recovery, and archiving of data are in place before actual deployment (see also SUP.8).*

DOP.1.BP4: Apply data quality activities and criteria.

Apply selected data quality activities, criteria, rules, and thresholds during data integration and deployment. Record and communicate the results and their potential impact on data quality and resolve problems.

NOTE 12: Typically, a mix of methods and activities is applied to understand and improve data quality, e.g., data assessment, profiling, cleansing, enrichment or data analyses.

DOP.1.BP5: Prepare for data operations.

Prepare stakeholders for data operations.

NOTE 13: Ensure preparation of stakeholders e.g., via training key users or support staff on the system.

NOTE 14: Consider identifying and managing risks related to stakeholder involvement during deployment.

DOP.1.BP6: Manage deployment.

Deploy data based on the data deployment approach and readiness of the data management system in line with the intended purpose. Record and communicate results of the deployment and resolve problems.

NOTE 15: Ensuring the readiness of the DMS can draw on a variety of activities ranging from inclusion of the support staff to setting up the target system on customer side to just a going live of the developed DMS. This might also include e.g. the flashing and configuration of the DMS.

NOTE 16: Typically, additional key measurements and criteria for the readiness of the DMS and other resources needed for operations are considered.

NOTE 17: Consider the connections to release management (SPL.2) and baselining (SUP.8) as basis for deploying data to the operating environment or release to customers.

DOP.1 Data integration and deployment	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7	Outcome 8		
Output information items										
08-DM01 Approach	X									
03-DM06 Data quality activities, criteria, rules, and thresholds		X		X						
03-DM00 Data			X							
03-DM01 Data set			X							
03-DM02 Metadata			X							
13-24 Validation record			X							
13-18 Quality record				X						
13-08 Installation record							X			
06-04 Training material						X				
13-51 Communication evidence					X	X		X		
Base Practices										
BP1: Specify data integration and deployment approach.	X									
BP2: Select data quality activities and criteria.		X								
BP3: Integrate, verify, and validate data.			X							
BP4: Apply data quality activities and criteria.				X	X					
BP5: Prepare for data operations.						X				
BP6: Manage deployment.							X	X		

DOP.1 – Rating rules	
Rating rules within the process	
[DOP.1.RL.1]	If the indicator for specifying a data integration deployment approach (DOP.1.BP1) is downrated, then DOP.1.BP2-6 shall not be rated higher than DOP.1.BP1.
Rating rules with other processes at level 1	
[DOP.1.RL.2]	If the indicator for specifying data quality (MGD.3.BP6) is downrated, then DOP.1.BP2 and DOP.1.BP4 shall not be rated higher than MGD.3.BP6.

2.2.2 DOP.2 Data operations and optimization

Process ID	**DOP.2**
Process name	**Data operations and optimization**
Process purpose	The purpose is to achieve the intended purpose during data operations by monitoring • the performance of the data management system, • the implementation of data governance, and • the achievement of data quality thresholds.
Process outcomes	As a result of successful implementation of this process: 1) Data operations and optimization approach are specified. 2) The performance of the data management system is monitored. 3) Data quality activities, criteria, rules, and thresholds are selected for data operations. 4) Data quality is monitored, understood, and optimized during data operations. 5) Achievement of data governance is monitored. 6) Intended purpose of data operations is achieved. 7) Results from monitoring data quality, the data management system, data governance, and achieving the intended purpose are recorded, evaluated and communicated.

Base practices	**DOP.2.BP1: Specify data operations and optimization approach.** Specify a data operations and optimization approach based on respective operational concepts and scenarios, the data management system, and the specified data flows. *NOTE 1: The approach addresses activities and criteria for planning, managing, and monitoring data operations and to ensure data operations achieves its intended purpose. The approach typically includes:* • *Reference to or specification of agreed on service levels of the DMS operations.* • *Activities to identify and handle (potential) disruptions and risks during data operations.* • *Activities to monitor and act on deviations from acceptable data quality.* • *Activities to manage resources and skills for the ongoing operation of the DMS.* • *Activities to identify and handle problems and trends (see SUP.9).* • *Activities to ensure data governance constraints.* • *Activities to ensure data quality.* • *Identified and addressed risks related to data operations (see MAN.5)*

DOP.2.BP2: Monitor data management system operations.

Monitor the performance of the data management system based on the data operations and optimization approach. Record, evaluate, and communicate the results.

NOTE 2: The availability or access of data in operations might be limited due to criteria like privacy, time, legal, local differences.

NOTE 3: Typically, criteria can be derived out of SLA's (Services Level Agreements) or DIA/SIA (Development / Supplier Interface Agreements).

DOP.2.BP3: Perform selected data quality activities.

Perform selected data quality activities, criteria, rules, and thresholds to understand and optimize data quality and consistency during data operations.

NOTE 4: Typically, the selection is recorded as part of the approach

NOTE 5: Typically, a mix of activities and methods is applied to understand and improve data quality, e.g., data assessment, profiling, cleansing, enrichment or data analysis.

NOTE 6: DOP.1 focuses on data quality before going live. DOP.2 focuses on continuous delivery/availability/sharing of data during data operations and on achieving the intended purpose

NOTE 7: Typically, results for data quality activities are used as a trigger for continuous optimization of data.

DOP.2.BP4: Monitor data quality.

Monitor data quality against selected criteria, rules, and thresholds during data operations. Record, evaluate, and communicate the results.

NOTE 8: The type of monitoring (continuous or event driven) and frequency of reporting depends on the respective criteria.

NOTE 9: Deviations from criteria, rules, and thresholds typically trigger problem management measures (see SUP.9) or further activities and methods for understanding and improving data quality.

DOP.2.BP5: Monitor data governance.

Monitor data governance constraints and ensure data governance during data operations. Record, evaluate, and communicate the results.

DOP.2.BP6: Ensure intended purpose.

Ensure consistency of data operations with the intended purpose. Record, evaluate, and communicate the results.

DOP.2 **Data operations and optimization**	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7			
Output information items										
08-DM01 Approach	X									
03-DM00 Data			X			X	X			
03-DM06 Data quality activities, criteria, rules, and thresholds			X							
11-DM01 Data management system		X								
07-08 Service level measure		X								
07-51 Measurement result							X			
13-06 Delivery record						X	X			
13-51 Communication evidence		X		X	X	X	X			
Base Practices										
BP1: Specify data operations and optimization approach.	X									
BP2: Monitor DMS operations.		X					X			
BP3: Perform selected data quality activities.			X							
BP4: Monitor data quality.				X			X			
BP5: Monitor data governance.					X		X			
BP6: Ensure intended purpose.						X	X			

DOP.2 – Rating rules	
Rating rules within the process	
[DOP.2.RL.1]	If the indicator for specifying a data operations and optimization approach (DOP.2.BP1) is downrated, then DOP.1.BP2-6 shall not be rated higher than DOP.2.BP1.
Rating rules with other processes at level 1	
[DOP.2.RL.2]	If the indicator for specifying a business case (MGD.1.BP3) is downrated, then DOP.1.BP6 shall not be rated higher than MGD.1.BP3.
[DOP.2.RL.3]	If the indicator for specifying data quality (MGD.3.BP6) is downrated, then DOP.2.BP6 shall not be rated higher than MGD.3.BP6.

2.3 Management process group (MAN)

For respective description of the following processes see Automotive SPICE® [6].

2.3.1 MAN.3 Project Management

2.3.2 MAN.5 Risk Management

2.4 Acquisition process group (ACQ)

For respective description of the following processes see Automotive SPICE® [6].

2.4.1 ACQ.4 Supplier Monitoring

2.5 Supporting process group (SUP)

For respective description of the following processes see Automotive SPICE® [6].

2.5.1 SUP.1 Quality Assurance

2.5.2 SUP.8 Configuration Management

2.5.3 SUP.9 Problem Management

2.5.4 SUP.10 Change Request Management

2.6 Supply process group (SPL)

For respective description of the following processes see Automotive SPICE® [6].

2.6.1 SPL.2 Product Release

2.7 Process improvement process group (PIM)

For respective description of the following processes see Automotive SPICE® [6].

2.7.1 PIM.3 Process Improvement

3. Process capability dimension: process capability levels and process attributes

The definition of process capability indicators for each process attribute is an integral part of a measurement framework. Process capability indicators such as generic practices and information items are the means to support the judgment of the degree of achievement of the associated process attribute.

This chapter defines the generic practices and information items and their mapping to the process attributes for each capability level. The capability level and process attribute definitions in Automotive SPICE® [6] are the based on ISO/IEC 33020:2019 [2].

Note: The Data Management SPICE measurement framework is an adaptation of ISO/IEC 33020:2019.

Due to lack of a defined process attribute for process capability level 0, no generic practices and information items are defined.

The following chapters are copies from §5 of Automotive SPICE® [6] and follow the structure of Table 22 in Automotive SPICE® [6]. Changes were applied only on the level of notes and examples provided within the generic practice descriptions.

For the definitions of the information item characteristics mentioned here, see Annex B in Automotive SPICE® [6].

3.1 Process capability level 0: Incomplete process

The process is not implemented or fails to achieve its process purpose. At this level there is little or no evidence of any systematic achievement of the process purpose.

3.2 Process capability level 1: Performed process

The implemented process achieves its process purpose. The following process attribute demonstrates the achievement of this level.

3.2.1 PA 1.1 Process performance process attribute

Process ID	**PA 1.1**
Process attribute name	**Process performance process attribute**
Process attribute scope	The process performance process attribute is a measure of the extent to which the process purpose is achieved.
Process attribute achievements	1) The process achieves its defined outcomes.

Generic Practices	**GP 1.1.1 Achieve the process outcomes** Achieve the intent of the base practices. Produce work products that evidence the process outcomes.

PA 1.1 **Process performance management attribute**	Achievement 1									
Output information items										
Process specific information items, as described in chapter 2	X									
Generic Practices										
GP 1.1.1 Achieve the process outcomes	X									

3.3 Process capability level 2: Managed process

The following process attributes, together with the previously defined process attribute, demonstrate the achievement of this level.

3.3.1 PA 2.1 Process performance management process attribute

Process ID	**PA 2.1**
Process attribute name	**Process performance management process attribute**
Process attribute scope	The performance management process attribute is a measure of the extent to which the performance of the process is managed.
Process attribute achievements	1) Strategy for the performance of the process is defined based on identified objectives. 2) Performance of the process is planned. 3) Performance of the process is monitored and adjusted to meet the planning. 4) Needs for human resources including responsibilities and authorities for performing the process are determined. 5) Needs for physical and material resources are determined. 6) Persons performing the process are prepared for executing their responsibilities. 7) Physical and material resources for performing the process are identified, made available, allocated and used. 8) Interfaces between the involved parties are managed to ensure both effective communication and the assignment of responsibilities.

Generic Practices	**GP 2.1.1: Identify the objectives and define a strategy for the performance of the process.** The scope of the process activities including the management of process performance and the management of work products are determined. Corresponding results to be achieved are determined. Process performance objectives and associated criteria are identified. *Note 1: Budget targets and delivery dates to the customer, targets for test coverage and process lead time are examples for process performance objectives.* *Note 2: Performance objectives are the basis for planning and monitoring.* Assumptions and constraints are considered when identifying the performance objectives. Approach and methodology for the process performance is determined.

	Note 3: A process performance strategy may not necessarily be documented specifically for each process. Elements applicable for multiple processes may be documented jointly, e.g., as part of a common data management and data quality strategy.
	GP 2.1.2: Plan the performance of the process. The planning for the performance of the process is established according to the defined objectives, criteria, and strategy. Process activities and work packages are defined. Estimates for work packages are identified using appropriate methods. *Note 4: Schedule and work rhythm are defined.*
	GP 2.1.3: Determine resource needs. The required amount of human resources, and experience, knowledge and skill needs for the for process performance are determined based on the planning. The needs for physical and material resources are determined based on planning. *Note 5: Physical and material resources may include equipment, laboratories, materials, tools, licenses etc.* Required responsibilities and authorities to perform the process, and to manage the corresponding work products are determined. *Note 6: The definition of responsibilities and authorities does not necessarily require formal role descriptions.*
	GP 2.1.4: Identify and make available resources. The individuals performing and managing the process are identified and allocated according to the determined needs. The individuals performing and managing the process are being qualified to execute their responsibilities. *Note 7: Qualification of individuals may include training, mentoring, or coaching.* The other resources, necessary for performing the process are identified, made available, allocated and used according to the determined needs.
	GP 2.1.5: Monitor and adjust the performance of the process. Process performance is monitored to identify deviations from the planning. Appropriate actions in case of deviations from the planning are taken. The planning is adjusted as necessary.
	GP 2.1.6: Manage the interfaces between involved parties. The individuals and groups including required external parties involved in the process performance are determined. Responsibilities are assigned to the relevant individuals or parties.

	Communication mechanisms between the involved parties are determined. Effective communication between the involved parties is established and maintained.

PA 2.1 **Process performance management attribute**	Achievement 1	Achievement 2	Achievement 3	Achievement 4	Achievement 5	Achievement 6	Achievement 7	Achievement 8		
Output information items										
19-01 Process performance strategy	X									
18-58 Process performance objectives	X									
14-10 Work package		X								
08-56 Schedule		X	X							
13-14 Progress status			X							
17-55 Resource needs				X	X					
08-61 Resource allocation						X	X			
08-62 Communication matrix								X		
13-52 Communication evidence								X		
Generic Practices										
GP 2.1.1: Identify the objectives and define a strategy for the performance of the process	X									
GP 2.1.2: Plan the performance of the process		X								
GP 2.1.3: Determine resource needs				X	X					
GP 2.1.4: Identify and make available resources						X	X			
GP 2.1.5: Monitor and adjust the performance of the process			X							
GP 2.1.6: Manage the interfaces between involved parties								X		

3.3.2 PA 2.2 Work product management process attribute

Process ID	**PA 2.2**
Process attribute name	**Work product management process attribute**
Process attribute scope	The work product management process attribute is a measure of the extent to which the work products produced by the process are appropriately managed.
Process attribute achievements	1) Requirements for the work products of the process are defined. 2) Requirements for storage and control of the work products are defined. 3) The work products are appropriately identified, stored, and controlled. 4) The work products are reviewed and adjusted as necessary to meet requirements.

Generic Practices	**GP 2.2.1 Define the requirements for the work products.** The requirements for the content and structure of the work products to be produced are defined. Quality criteria for the work products are identified. Appropriate review and approval criteria for the work products are defined. *Note 1: Possible sources of documentation requirements may be e.g., best practices or lessons learned from other projects, standards, organization requirements, customer requirements, etc.* *Note 2: There may be types of work products for which no review or approval is required, thus then there would be no need to define the corresponding criteria.*
	GP 2.2.2 Define the requirements for storage and control of the work products. Requirements for the storage and control of the work products are defined, including their identification and distribution. *Note 3: Possible sources for the identification of requirements for storage and control may be e.g., legal requirements, data policies, best practices from other projects, tool related requirements, etc.* *Note 4: Examples for work product storage are files in a file system, ticket in a tool, Wiki entry, paper documents etc.* *Note 5: Where status of a work product is required in base practices, this should be managed via a defined status model.*
	GP 2.2.3 Identify, store and control the work products. The work products to be controlled are identified. The work products are stored and controlled in accordance with the requirements. Change control is established for work products.

	Versioning and baselining of the work products is performed in accordance with the requirements for storage and control of the work products. The work products including the revision status are made available through appropriate mechanisms.
	GP 2.2.4 Review and adjust work products. The work products are reviewed against the defined requirements and criteria. Resolution of issues arising from work products reviews is ensured.

PA 2.2 **Work product management process attribute**	Achievement 1	Achievement 2	Achievement 3	Achievement 4						
17-05 Requirements for work products	X	X								
18-59 Review and approval criteria for work products	X									
18-07 Quality criteria	X									
13-19 Review evidence				X						
13-08 Baseline			X							
16-00 Repository			X							
GP 2.2.1 Define the requirements for the work products	X									
GP 2.2.2 Define the requirements for storage and control of the work products		X								
GP 2.2.3 Identify, store and control the work products			X							
GP 2.2.4 Review and adjust work products				X						

3.4 Process capability level 3: Established process

The following process attributes, together with the previously defined process attribute, demonstrate the achievement of this level.

3.4.1 PA 3.1 Process definition process attribute

Process ID	**PA 3.1**
Process attribute name	**Process definition process attribute**
Process attribute scope	The process definition process attribute is a measure of the extent to which a standard process is maintained to support the deployment of the defined process.
Process attribute achievements	1) A standard process is developed, established, and maintained that describes the fundamental elements that must be incorporated into a defined process. 2) The required inputs and the expected outputs for the standard process are defined. 3) Roles, responsibilities, authorities, and required competencies for performing the standard process are defined. 4) Tailoring guidelines for deriving the defined process from the standard process are defined. 5) Required physical and material resources and process infrastructure needs are determined as part of the standard process. 6) Suitable methods and required activities for monitoring the effectiveness, suitability and adequacy of the process are determined.

Generic Practices	**GP 3.1.1 Establish and maintain the standard process.** A suitable standard process is developed including required activities and their interactions. Inputs and outputs of the standard process are defined including the corresponding entry and exit criteria to determine the interactions and sequence with other processes. Process performance roles are identified and assigned to the standard process activities including their type of involvement, responsibilities, and authorities. *Note 1: An example for describing the involvement of the process roles in the activities is a RASI/RASIC representation.* Suitable guidance, procedures, and templates are provided to support the execution of the process as needed. *Note 2: Procedures may also include description of specific methods to be used.*

	Appropriate tailoring guidelines including predefined unambiguous criteria as well as predefined and unambiguous proceedings are defined based on identified deployment needs and context of the standard process. The standard process is maintained according to corresponding feedback from the monitoring of the deployed processes. *Note 3: For guidance on how to perform process improvements see the Process Improvement process (PIM.3)*
	GP 3.1.2 Determine the required competencies. Required competencies, skills, and experience for performing the standard process are determined for the identified roles. Appropriate qualification methods to acquire the necessary competencies and skills are determined, maintained, and made available for the identified roles. *Note 4: Qualification methods are e.g., training, mentoring, self-study.* *Note 5: Preparation includes e.g., identification or definition of training, mentoring concepts, self-learning material.*
	GP 3.1.3 Determine the required resources. Required physical and material resources and process infrastructure needs for performing the standard process are determined. *Note 6: This may include e.g., facilities, tools, licenses, networks, services, and samples supporting the establishment of the required work environment.*
	GP 3.1.4 Determine suitable methods to monitor the standard process. Methods and required activities for monitoring the effectiveness and adequacy of the standard process are determined. *Note 7: Methods and activities to gather feedback regarding the standard process may be lessons learned, process compliance checks, internal audits, management reviews, change requests, reflection of state-of-the-art such as applicable international standards, etc.* Appropriate criteria and information needed to monitor the standard process are defined. *Note 8: Information about process performance may be of qualitative or quantitative nature.*

PA 3.1 **Process definition process attribute**	Achievement 1	Achievement 2	Achievement 3	Achievement 4	Achievement 5	Achievement 6				
Output information items										
06-51 Tailoring guideline				X						
08-63 Process monitoring method						X				
10-00 Process description	X	X								
10-50 Role description			X							
10-51 Qualification method description			X							
10-52 Process resource and infrastructure description					X					
Generic Practices										
GP 3.1.1 Establish and maintain the standard process.	X	X	X	X						
GP 3.1.2 Determine the required competencies			X							
GP 3.1.3 Determine the required resources				X						
GP 3.1.4 Determine suitable methods to monitor the standard process					X					

3.4.2 PA 3.2 Process deployment process attribute

Process ID	**PA 3.2**
Process attribute name	**Process deployment process attribute**
Process attribute scope	The process deployment process attribute is a measure of the extent to which the standard process is deployed as a defined process to achieve its process outcomes.
Process attribute achievements	1) A defined process is deployed based upon an appropriately selected and/or tailored standard process. 2) Assignment of persons necessary for performing the defined process to roles is performed and communicated. 3) Required education, training and experience is ensured and monitored for the person(s) assigned to the roles. 4) Required resources for performing the defined process are made available, allocated, and maintained. 5) Appropriate information is collected and analyzed as a basis for understanding the behavior of the process

Generic Practices	GP 3.2.1 Deploy a defined process that satisfies the context specific requirements of the use of the standard process. The defined process is appropriately selected and/or tailored from the standard process. Conformance of defined process with standard process requirements and tailoring criteria is verified. The defined process is used as managed process to achieve the process outcomes. *Note 1: Changes in the standard process may require updates of the defined process. Suitable guidance, procedures, and templates are provided to support the execution of the process as needed.*
	GP 3.2.2 Ensure required competencies for the defined roles. Human resources are allocated to the defined roles according to the required competencies and skills. Assignment of persons to roles and corresponding responsibilities and authorities for performing the defined process are communicated. Gaps in competencies and skills are identified, and corresponding qualification measures are initiated and monitored.
	GP 3.2.3 Ensure required resources to support the performance of the defined process.

	Required information to perform the defined process is made available, allocated and used. Required physical and material resources, process infrastructure and work environment are made available, allocated and used. Availability and usage of resources are measured and monitored.
	GP 3.2.4 Monitor the performance of the defined process. Information is collected and analyzed according to the determined process monitoring methods to understand the effectiveness and adequacy of the defined process. Results of the analysis are made available to all effected parties and used to identify where continual improvement of the standard and/or defined process can be made. *Note 2: For guidance on how to perform process improvements see the Process Improvement process (PIM.3).*

PA 3.2 **Process deployment process attribute**	Achievement 1	Achievement 2	Achievement 3	Achievement 4	Achievement 5					
10-00 Process description	X									
15-54 Tailoring documentation	X									
14-53 Role assignment		X	X							
13-55 Process resource and infrastructure documentation				X						
03-06 Process performance information					X					
Generic Practices										
GP 3.2.1 Deploy a defined process.	X									
GP 3.2.2 Ensure required competencies		X	X							
GP 3.2.3 Ensure required resources				X						
GP 3.2.4 Monitor the performance of the defined process					X					

3.5 Process capability level 4: Predictable process

The following process attributes, together with the previously defined process attribute, demonstrate the achievement of this level.

3.5.1 PA 4.1 Quantitative analysis process attribute

Process ID	**PA 4.1**
Process attribute name	**Quantitative analysis process attribute**
Process attribute scope	The quantitative analysis process attribute is a measure of the extent to which information needs are defined, relationships between process elements are identified and data are collected.
Process attribute achievements	1) Process information needs in support of relevant defined quantitative business goals are established. 2) Measurable relationships between process elements that contribute to the process performance, and data collection techniques and data collection frequency, are identified. 3) Process measurement objectives are derived from process information needs. 4) Techniques for analyzing the collected data are selected. 5) Quantitative control limits for process performance in support of relevant business goals are established. 6) Results of measurement are collected, validated and reported in order to monitor the extent to which the quantitative targets/objectives for process performance are met. *Note: Information needs typically reflect management, technical, project, process or product needs.*

Generic Practices	**GP 4.1.1 Identify business goals.** Business goals are identified that are supported by the quantitatively measured process.
	GP 4.1.2 Establish process information needs. Stakeholders of the identified business goals and the quantitatively measured process are identified, and their information needs are defined and agreed.
	GP 4.1.3 Identify measurable relationships between process elements. Identify the relationships between process elements, or sets of process elements, which contribute to the process information needs. *Note 1: Examples of process elements are work products, activities, tasks.*

	GP 4.1.4 Derive process measurement approach and select analysis techniques. Based on the measurable relationships of process elements, or set of process elements, the process measurement metrics are derived to satisfy the established process information needs. Frequency of data collection is defined. Select analysis techniques, appropriate to collected data. Algorithms and methods to create derived measurement results from base measures are defined, as appropriate. Verification mechanism for base and derived measures is defined. *Note 2: Typically, the standard process definition is extended to include the collection of data for process measurement.*
	GP 4.1.5 Establish quantitative control limits. Establish quantitative control limits for the derived metrics. Agreement with process stakeholders is established.
	GP 4.1.6 Collect product and process measurement results through performing the defined process. Data collection mechanisms are created for all identified metrics. Required data is collected across process instances of within the defined frequency and recorded. Measurement results are analyzed and reported to the identified stakeholders. *Note 3: A product measure can contribute to a process measure, e.g., the productivity of testing characterized by the number of defects found in a given timeframe in relation to the product defect rate in the field.*

PA 4.1 Quantitative analysis process attribute	Achievement 1	Achievement 2	Achievement 3	Achievement 4	Achievement 5	Achievement 6				
Output information items										
18-70 Business goals	X	X								
07-61 Quantitative process metric		X	X							
07-62 Process analysis techniques				X						
07-63 Process control limits					X					
07-64 Process measurement data						X				
Generic Practices										
GP 4.1.1 Identify business goals	X									
GP 4.1.2 Establish process information needs	X									
GP 4.1.3 Identify measurable relationships between process elements		X								
GP 4.1.4 Derive process measurement approach and select analysis techniques			X	X						
GP 4.1.5 Establish quantitative control limits					X					
GP 4.1.6 Collect product and process measurement results through performing the de-fined process						X				

3.5.2 PA 4.2 Quantitative control process attribute

Process ID	**PA 4.2**
Process attribute name	**Quantitative control process attribute**
Process attribute scope	The quantitative control process attribute is a measure of the extent to which objective data are used to manage process performance that is predictable.
Process attribute achievements	1) Variations in process performance are identified. 2) Assignable causes of process variation are determined through analysis of the collected quantitative data. 3) Distributions that characterize the performance of the process are established. 4) Corrective actions are taken to address assignable causes of variation.

Generic Practices	**GP 4.2.1 Identify variations in process performance.** Deviations in the performance of process instances from the established quantitative control limits are determined based on the collected quantitative measurement data.
	GP 4.2.2 Identify causes of variation. The determined deviations in process performance are analyzed to identify potential cause(s) of variation using the defined analysis techniques. Distributions are used to quantitatively understand the variation of process performance under the influence of potential causes of variation. Consequences of process variation are analyzed.
	GP 4.2.3 Identify and implement corrective actions to address assignable causes. Results are provided to those responsible for taking action. Corrective actions are determined and implemented to address each assignable cause of variation. Corrective action results are monitored and evaluated to determine their effectiveness. *Note 1: Assignable cause may indicate a possible problem in the defined process.*

PA 4.2 **Quantitative control process attribute**	Achievement 1	Achievement 2	Achievement 3	Achievement 4						
15-57 Quantitative process analysis results	X	X	X							
08-66 Measures against deviations in quantitative process analysis				X						
Generic Practices										
GP 4.2.1 Identify variations in process performance.	X									
GP 4.2.2 Identify causes of variation		X	X							
GP 3.2.3 Ensure required resources				X						
GP 3.2.4 Monitor the performance of the defined process				X						

3.6 Process capability level 5: Innovating process

The following process attributes, together with the previously defined process attribute, demonstrate the achievement of this level.

3.6.1 PA 5.1 Process innovation process attribute

Process ID	**PA 5.1**
Process attribute name	**Quantitative innovation process attribute**
Process attribute scope	The process innovation process attribute is a measure of the extent to which changes to the process are identified from investigations of innovative approaches to the definition and deployment of the process.
Process attribute achievements	1) Process innovation objectives are defined that support the relevant business goals. 2) Quantitative data are analyzed to identify opportunities for innovation. 3) Innovation opportunities derived from new technologies and process concepts are identified.

Generic Practices	**GP 5.1.1 Define the process innovation objectives for the process that support the relevant business goals.** New business visions and goals are analyzed to give guidance for new process objectives and potential areas of process innovation. Quantitative and qualitative process innovation objectives are defined and documented.
	GP 5.1.2 Analyze quantitative data of the process. Common causes of variation in process performance across process instances are identified and analyzed to get a quantitative understanding of their impact.
	GP 5.1.3 Identify innovation opportunities. Identify opportunities for innovation based on the quantitative understanding of the analyzed data. Industry best practices, new technologies and process concepts are identified and evaluated. Feedback on opportunities for innovation is actively sought. Emergent risks are considered in evaluating improvement opportunities.

PA 5.1 Process innovation process attribute	Achievement 1	Achievement 2	Achievement 3							
Output information items										
18-80 Improvement opportunity	X		X							
15-58 Common cause of variation analysis results		X								
Generic Practices										
GP 5.1.1 Define the process innovation objectives for the process that support the relevant business goals	X									
GP 5.1.2 Analyze quantitative data of the process		X								
GP 5.1.3 Identify innovation opportunities			X							

3.6.2 PA 5.2 Process innovation implementation process attribute

Process ID	**PA 5.2**
Process attribute name	**Process innovation implementation process attribute**
Process attribute scope	The process innovation process implementation attribute is a measure of the extent to which changes to the definition, management and performance of the process achieves the relevant process innovation objectives.
Process attribute achievements	1) Impact of all proposed changes is assessed against the objectives of the defined process and standard process. 2) Implementation of all agreed changes is managed to ensure that any disruption to the process performance is understood and acted upon. 3) Effectiveness of process change on the basis of quantitative performance and innovation feedback is evaluated.

Generic Practices	**GP 5.2.1 Define and assess the impact of proposed changes.** Specified changes are assessed against product quality and process performance requirements and goals. Impact of changes to other defined and standard processes is considered. Objective priorities for process innovation are established. Commitment to innovation is demonstrated by organizational management including other relevant stakeholders.

	GP 5.2.2 Implement agreed process changes. A mechanism is established for incorporating accepted changes into the defined and standard process(es) effectively and completely. Process changes are implemented and effectively communicated to all affected parties.
	GP 5.2.3 Evaluate the effectiveness of process change. Performance and capability of the changed process are measured and compared with historical data. Performance and capability of the changed process are analyzed to determine whether the process performance has improved with respect to common causes of variations. Other feedback is recorded, such as opportunities for further innovation of the standard process. A mechanism is available for documenting and reporting analysis results to stakeholders of standard and defined process.

PA 5.2 **Process innovation implementation process attribute**	Achievement 1	Achievement 2	Achievement 3							
Output information items										
18-81 Improvement evaluation results	X		X							
08-66 Measures against deviations in quantitative process analysis		X	X							
Generic Practices										
GP 5.2.1 Define and assess the impact of proposed changes	X									
GP 5.2.2 Implement agreed process changes		X								
GP 5.2.3 Evaluate the effectiveness of process change			X							

Annex A – Conformity of the Data Management SPICE PRM/PAM

Data Management SPICE PRM/PAM is compliant to the requirements for conformance defined in ISO/IEC 33004 [4]. The PAM can be used to perform assessments that meet the requirements of ISO/IEC 33002 [2].

This clause contains the demonstration of conformity of Process Reference Model and Process Assessment Model according to the requirements defined in ISO/IEC 33004 [4], clauses 5.5 and 6.4.

Due to copyright reasons each requirement is only referred to by its number and title. The full text of the requirements can be drawn from the ISO/IEC 33004 [4].

Conformance to the requirements for PRMs

Clause 5.3, 'Requirements for process reference models'

The following information is provided in Section 1 and 2 of this document:

- The declaration of the domain of this PRM/PAM document.
- The description of the relationship between this PRM/PAM document and its intended context of use.
- The description of the relationship between the processes defined within this PRM/PAM.

The descriptions of the processes within the scope of this PRM/PAM document fulfilling the requirements of ISO/IEC 33004 clause 5.3 is provided in the Sections 2.1 – 2.7 of this PRM/PAM document. [ISO/IEC 33004 [4], 5.3.1]

The relevant communities of interest and their mode of use and the consensus achieved for this Data Management PRM is documented in the Preamble under 'Community of interest' and the scope of this document in section 1.3. [ISO/IEC 33004 [4], clause 5.3.2]

The process descriptions are unique. The identification is provided by unique names and by the identifier of each process of this document, see Section 2 of this document. [ISO/IEC 33004 [4], clause 5.3.3]

Clause 5.4, 'Process descriptions'

These requirements are met by the process descriptions in chapter 2 of this PRM/PAM document. [ISO/IEC 33004 [4], clause 5.4 and 5.3.1 c].

Conformance to the requirements for PAMs

Clause 6.1, 'Introduction'

The purpose of this PAM is to support assessment of process capability within the automotive domain using the process measurement framework defined in ISO/IEC 33020:2019[5]. [ISO/IEC 33004 [4], clause 6.1]

Clause 6.2, 'Process Assessment Model scope'

The PAM is based on the process description of the PRM as stated in the Editorial Guidance in Section 2 and as referenced in the tables describing each process in the Sections 2.1 – 2.7.

The PRM in this document is conformant to the requirements of ISO/IEC 33004 [4], clause 5.3 and 5.4, as described above. The process capability levels of this PAM are defined in the process measurement

framework based on Automotive SPICE® [6] and contained in chapter 3, which is conformant with the process measurement framework in ISO/IEC 33020:2019 that is satisfying the requirements of ISO/IEC 33003 [3]. [ISO/IEC 33004 [4], clause 6.2].

Clause 6.3, 'Requirements for process assessments models'

The PAM in this document is related to process capability. [ISO/IEC 33004 [4], clause 6.3.1]

This PAM incorporates the process measurement framework specified in Automotive SPICE® [6], which is conformant with the process measurement framework in ISO/IEC 33020:2019 that is satisfying the requirements of ISO/IEC 33003 [3]. [ISO/IEC 33004 [4], clause 6.3.2]

This PAM is based on the PRM included in Section 2 of this document. This PAM is further based on the process measurement framework specified in Automotive SPICE® [6], which is conformant with the process measurement framework in ISO/IEC 33020:2019 [5] that is satisfying the requirements of ISO/IEC 33003 [3]. [ISO/IEC 33004 [4], clause 6.3.3]

The processes included in this PAM are identical to those specified in the PRM. [ISO/IEC 33004, 6.3.4]

For all processes in this PAM all levels defined in the process measurement framework from ISO/IEC 33020:2019 are addressed. This is done via adopting the process measurement framework specified in Automotive SPICE® [6], which is conformant with the process measurement framework in ISO/IEC 33020:2019 that is satisfying the requirements of ISO/IEC 33003 [3]. [ISO/IEC 33004 [4], clause 6.3.5]

This PAM defines

1. the selected process quality characteristic
2. the selected process measurement framework
3. the selected PRM
4. the selected processes from the PRM [ISO/IEC 33004 [4], clause 6.3.5 a-d]

Concerning the capability dimension this PAM addresses all of the Process Attributes and Capability Levels defined in the process measurement framework of ISO/IEC 33020:2019 [5]. This is done via adopting the process measurement framework specified in Automotive SPICE® [6], which is conformant with the process measurement framework in ISO/IEC 33020:2019 [5] that is satisfying the requirements of ISO/IEC 33003 [3]. [ISO/IEC 33004 [4], clause 6.3.5 e]

Clause 6.3.8, 'Assessment indicators'

The PAM in this document provides a two-dimensional view of process capability for the processes in the PRM, through the definition of assessment indicators in Section 2. The assessment indicators used are:

- Base Practices and output information items explicitly addressing the outcomes of the respective process of the PRM. [ISO/IEC 33004 [4], clause 6.3.8 a]
- Generic Practices to demonstrate the achievement of the process attributes as stated in Section 2.6 of this document. [ISO/IEC 33004 [4], clause 6.3.8 b]

Clause 6.3.9, 'Mapping process assessment models'

The mapping of the assessment indicators to the purpose and process outcomes of the processes in the PRM is included in each description of the Base Practices in the Sections 2.1-2.5 [ISO/IEC 33004 [4], clause 6.3.9.1]

The mapping of the assessment indicators to the Process Attributes in the process measurement framework including all the Process Attribute achievements is included in the description of the Generic Practices in the process measurement framework specified in Automotive SPICE ® [6], which is conformant with the process measurement framework in ISO/IEC 33020:2019 [5] that is satisfying the requirements of ISO/IEC 33003 [3]. Each mapping is indicated by a reference in square brackets. [ISO/IEC 33004 [4], clause 6.3.9.2, 'Mapping PAMs']

Clause 6.3.10, 'Expression of assessment results'

The Process Attributes and the Process Attribute ratings in this PAM are identical to those defined in the measurement framework of Automotive SPICE® [6]. Consequently, results of assessments based upon this PAM are expressed directly as a set of Process Attribute ratings for each process within the scope of the assessment. No form of translation or conversion is required. [ISO/IEC 33004 [4], clause 6.3.10].

Annex B – Data Management SPICE guideline on interpretation of Automotive SPICE® PRM/PAM

This section supports the interpretation of the base practices of the selected processes of Automotive SPICE® PRM/PAM (CL1) in the context of data management.

The interpretation guideline supports both assessments and improvements in the appropriate evaluation of the respective base practices in the context of data management.

However, this whole guideline serves as a recommendation only and not as mandatory content!

Annex B.1 – MAN.3 Project Management

Please refer to the definition of organizational unit for a short discussion on the term "project". In context of data management, we are considering project management as work management depending on the selected organizational unit in context of the assessment scope.

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Define the scope of work.	Consider different types of data management projects (organizational units) when thinking about goals, motivation, and boundaries, e.g., the setup of a complete data management system/environment; the transfer of data to operations or for managing data in operations within an organizational unit or any combination thereof. There is an overlap between "scope of work" in MAN.3.BP1 and "scope of data management" in MGD.1.BP1. Whereas scope of work refers to all activities to be considered in doing the work across the data lifecycle/ flow, scope of data management addresses data specific topics and data governance as input to the business case.
BP2: Define project life cycle.	The project life cycle does not depend on the data life cycle, but rather on the scope of work, see BP1. A project (work) lifecycle focuses on the stages of work related to managing data, e.g., design – build – run. Consider that there are often multiple levels (instances) of estimation and planning within each stage of work management, e.g., on organization, department, and unit or team level - each with a different cadence of estimation and planning and tracking work.
BP3: Evaluate feasibility of the project.	Typically, feasibility is considered during creation of the business case. Feasibility could focus on whether the required data can be integrated, availability of tools and infrastructure, availability of data sources, existing skills/competences, etc.

BP4: Define and monitor work packages.	The activities and their dependencies should be aligned with the data life cycle and data flow. See also comments regarding scope in BP1. Work activities typically cover data quality, data management, and data operations, as well as general management and supporting processes.
BP5: Define and monitor project estimates and resources.	Consider different estimation methods for data management depending on the type of work, see BP1 and BP2 comments. Consider work related risks as well as risks related to data integration, verification, validation, and quality activities. Estimations and resources typically cover activities related to data quality, management, and operations, as well as general management and supporting processes with additional data context.
BP6: Define and monitor required skills, knowledge, and experience.	Required data management skills may include knowledge of e.g., statistics, data modelling, data analytics, data protection and security.
BP7: Define and monitor project interfaces and agreed commitments.	There is an overlap between “project interfaces” in MAN.3.BP7 and “stakeholders” in MGD.1.BP2. Interfaces in MAN.3 refers to all work-related interfaces of the organizational unit to handle data management related work. Whereas the stakeholders in MGD.1 refer to all stakeholders for the scope of data management and focus mainly on those providing needs, requirements and solutions for data management and data quality. Both work interfaces and stakeholders for data management encompass e.g., data quality, work management, and data deployment and operations. Also consider interfaces and stakeholders related to designing, building, and running data management systems as well as organizational interfaces like IT operations, data protection and security, legal staff, purchasing, etc... I.e. anyone involved in or contributing to or being affected by work across the data lifecycle/ flow. Interfaces may include work that shares or uses the same data source/ data sets / platform/ etc..
BP8: Define and monitor project schedule.	This relates to all data quality, data management, data deployment, and data operation activities as well as general management and supporting processes with data management context. Consider the different cadence of work regarding data management activities. Also consider activities for archiving, deletion, and retirement of data. If significant data quality issues are identified, the schedule needs to accommodate the time and effort required for remedial activities.

	Any targets with regards to data retention, deletion or reporting due to regulations should be reflected in the schedule.
BP9: Ensure consistency.	Regularly adjust estimates, resources, skills, work packages and their dependencies, schedules, plans, interfaces, and commitments to ensure consistency with the scope of work.
BP10: Review and report progress of the project.	Consider the different levels/ instances of work depending on the organizational unit in scope, see BP1/ BP2 comments.

Annex B.2 – MAN.5 Risk Management

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Identify sources of risks.	Consider risks across the whole data lifecycle and data flow. Typically, risks for data deployment and operations relate both to data quality and continuous operation of the data management system. Consider potential incident/disruptions also as risks. Clearly define the distinction between risks for the organizational unit and the related business case and risks related to business continuity (i.e., interruptions of work with major impact on business operations). Business continuity is not in scope (please refer to respective processes in SPICE for IT Services).
BP2: Identify potential undesirable events.	-
BP3: Determine risks.	-
BP4: Define risk treatment options.	-
BP5: Define and perform risk treatment activities.	-
BP6: Monitor risks	-
BP7: Take corrective action.	-

Annex B.3 – ACQ.4 Supplier Monitoring

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Agree on and maintain joint activities, joint interfaces, and information to be exchanged.	Typically, suppliers can be involved in any stage, from designing and building the data flow to data deployment and operations. It can range from dedicated suppliers of data sources to the complete operation of the data management system. As part of the agreement with suppliers providing or processing data, consider how to handle points of demarcation and ownership of data, data protection and security, and data quality. Joint processes and interfaces for data management typically address practices related to MGD.3 and DOP.2. Additional joint processes depend on the agreed responsibilities (points of demarcation, data sources) in the data life cycle; see also MGD.3.BP3-5. Typically, in case of an outsourced data management system, the definition of related measures and metrics (e.g., service levels) should be considered.
BP2: Exchange all agreed information.	Consider procedures for handling issues and defective data during (an ongoing) exchange. Typically, mechanisms are installed to handle failures or corrupt data during transfer. Also consider secure transmission of data.
BP3: Review development work products with the supplier.	Typically, (automated) checks and reviews of (processed) data are performed before and during data deployment. Typically, appropriate version control, backups, and access management should be in place on the supplier side before releasing data. Typically, data quality criteria, rules, and thresholds are tracked and reported.
BP4: Review progress of the supplier.	Regular reviews could include assessments of the supplier ‘s adherence to agreed upon data governance criteria.
BP5: Act to correct deviations.	In case of objectives not being met (both for progress and for data quality) agree on corrective measures and track them to closure. Consider and agree on “down time or recovery times” in case of time critical data being provided. Consider causal analysis of any recurring deviation from objectives as input for continuous improvement of data management on both sides.

Annex B.4 – SUP.1 Quality Assurance

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Ensure independence of quality assurance.	From an implementation perspective, quality assurance roles could cover aspects of data quality. Especially looking at the results of data quality criteria, rules, and thresholds. However, QA is not responsible for the data quality itself but can support in monitoring the adherence to agreed data quality requirements.
BP2: Define criteria for quality assurance.	
BP3: Assure quality of work products.	Quality assurance has to ensure process adherence for all work products related to data management, management, acquisition, and supporting processes.
BP4: Assure quality of process activities.	Quality assurance ensures process adherence for all activities related to data management, management, and supporting processes.
BP5: Summarize and communicate quality assurance activities and result.	-
BP6: Ensure resolution of non-conformances.	-
BP7: Escalate non-conformances.	-

Annex B.5 – SUP.8 Configuration Management

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Identify configuration items.	Typically, the data life cycle and data flow should be reflected in the configuration management approach.
BP2: Define configuration item properties.	Usually, the description of data is reflected in the metadata. Data of any type can be a configuration item.
BP3: Establish a configuration management system.	Typically, multiple repositories are used to store different types of data. Consider how the configuration of the whole data management system is handled.

BP4: Control modifications.	Control modifications relate to how data changes and updates are controlled for review, approval, and release. For managing the content of a release and its consistency refer to SPL.2 and MAN.3. For ensuring the data quality refer to both data deployment and data operations (DOP.1, DOP.2).
BP5: Establish baselines.	For continuously available data (e.g., data as a service) baselining refers to the individual data or data sets and their life cycle as well as to all its quality criteria applied to them.
BP6: Summarize and communicate configuration status.	The status of the data/ data sets should be part of the reporting (c.f. BP2 and the defined data life cycle).
BP7: Ensure completeness and consistency.	
BP8: Verify backup and recovery mechanisms availability.	Consider also regulatory constraints regarding data retention and archiving.

Annex B.6 – SUP.9 Problem Resolution Management

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Identify and record the problem.	Problem resolution activities can be different across data lifecycles and data flows and depend on the usage scenario for data management. Anytime practices in data management processes talk about resolving problems, this process here is called upon. Problems also include any kind of incident or disruption of the data management system during deployment or operations.
BP2: Determine the cause and the impact of the problem.	In data management, the origin of the problem is often not located in the data itself but, for example, in a system creating or providing the data (incl. suppliers).
BP3: Authorize urgent resolution action.	In data management urgent resolution is not always possible, e.g., in the context of machine learning scenarios.
BP4: Raise alert notifications.	In the data management (and any other) context, the impact may be on other business cases / customers of the organization.
BP5: Initiate problem resolution.	-

BP6: Track problems to closure.	-
BP7: Report the status of problem resolution activities.	-

Annex B.7 – SUP.10 Change Request Management

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Identify and record the change requests.	-
BP2: Analyze and assess change requests.	-
BP3: Approve change requests before implementation.	-
BP4: Establish bidirectional traceability.	-
BP5: Confirm the implementation of change requests.	-
BP6: Track change requests to closure.	-

Annex B.8 – SPL.2 Product Release

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Define the functional content of releases.	Establish data sets and content criteria for the release package. Define the specific data (e.g., data sets, configurations or metadata) included in the release. Use a data catalog or metadata repository to document data sources and relationships. Ensure data included in the release meets quality criteria to support processes like verification or deployment.
BP2: Define release package.	Include all relevant data (e.g., data sets, configuration files, database schemas) in the release package. Consider to provide metadata that describes the data's structure, origin and usage constraints to facilitate proper handling by the recipients.
BP3: Ensure unique identification of releases.	Consider unique data identifiers (e.g., a version number, release tags, build ID or cryptographic hash) to data artifacts within the release (ideally already handled by SUP.8). This unique identifier is critical for traceability, preventing errors in deployment and linking the release to all associated records (e.g., approvals, test results, release notes, etc.), as well as ensure secure storage and transmission of data.
BP4: Build the release from items under configuration control.	The released data package should be accurate containing trusted snapshots of the configured items, thereby preventing the introduction of unapproved or untracked data. Ensure all data artifacts (e.g., data sets, configuration files) are stored in a configuration management system with version control to maintain a single source of truth (see also SUP.8).
BP5: Ensure release approval before delivery.	Ensure data quality and compliance with requirements (e.g., functional, regulatory or security standards) before approving the release. This may also involve data quality checks or automated validation scripts. Delivery of the release package only after approval of data (e.g., electronic signatures, timestamps, approval records) is complete and valid.
BP6: Provide a release note.	Include detailed information about data changes (e.g., new datasets, updates to data flow or data fixes, etc.) in the release notes to inform users of data-related updates.

	Updated (meta)data repositories should reflect changes in the data included in the release, ensuring users have access to accurate documentation.
BP7: Communicate the type, service level and duration of support for a release.	Specify the support details for data components, such as data maintenance schedule, update frequency or data retention policies. Communicate the duration for which data in the release will be supported, including archiving in order to align with data governance frameworks.
BP8: Deliver the release package to the intended customer	Use secure protocols for delivering release packages containing data to ensure confidentiality and integrity during transfer in accordance with data management practices.

Annex B.9 – PIM.3 Process Improvement

Base Practice (short titles only)	Interpretation guideline in context of data management
BP1: Establish commitment.	Typically, stakeholders for a data management initiative or product vary depending on the usage scenario. In case of e.g., internal data like for CRM/ERP systems, organizational entities like e.g., business administration, product life cycle management, sales, marketing, IT, and service units should be considered.
BP2: Identify improvement measures.	-
BP3: Establish process improvement goals.	-
BP4: Prioritize improvements.	-
BP5: Define process improvement measures.	-
BP6: Implement process improvement measures	-
BP7: Confirm process improvement.	-
BP8: Communicate results of improvement.	-

Annex C – Guideline for interfaces and comparisons of Data Management SPICE to other standards

Annex C.1 Interface to Machine Learning as part of Automotive SPICE PAM 4.0

Data Management (DM) SPICE focuses on data governance, data quality and data management to support reliable data-driven decision-making. The objectives are to support the improvement of data storage, data processing, data deployment, and data quality including activities such as collection, processing, structuring, and updates over the whole data lifecycle. DM SPICE also considers data protection, security, and access management as part of data governance. DM SPICE can be applied to any kind of data in any kind of enterprises or organizations incl. governmental or administration.

Whereas Machine Learning (ML) SPICE focuses on the lifecycle of ML models and their optimization aiming for the improvement of workflows and models by model training, evaluation, and monitoring. Bias detection, fairness and model explainability are crucial for achieving good results in ML projects.

Data management will help to ensure that the data collection and processing meets the specific requirements of ML projects regarding data quality. This includes criteria like relevance, completeness, and appropriate data selection for bias mitigation.

	Machine Learning SPICE	Data Management SPICE	Integration Approach
Focus Area	ML model lifecycle and optimization	Data governance, data quality and data management	Ensuring high-quality data for ML models for development and operation.
Objective	Improve ML development and ML models	Improve data collection, storage, processing, data deployment, operations and quality	Enable provision of reliable data processing for ML development and execution
Key Activities	Model training, evaluation and monitoring	Data management and data flow, data quality and governance	Data preprocessing, feature engineering, ML data governance
Adherence and conformance to regulations	Bias detection, fairness, model explainability	Data protection and security, consistency, accuracy	Ensuring ethical and unbiased ML with compliant data usage
Application	AI/ML-driven systems and automation, and their development	Data management practices in the context of an organizational unit.	Seamless[2] data flow and compliance for AI/ML driven models and their development
Model Type	Assessment	Assessment	Combined Assessment
Applicability	Organizational unit	Organizational unit	Organizational unit
Benefit	Maturity & excellence, regulatory compliance	Maturity & excellence, regulatory compliance	Maturity & excellence, regulatory compliance

Table 2: Comparing Data Management SPICE and Machine Learning in Automotive SPICE

[2] Seamless can be interpreted as traceable, timeliness, access control and format compatibility

Handling SUP.11 of ML SPICE PAM in context of DM SPICE

The process SUP.11 of ML SPICE PAM 4.0 overlaps with the DM SPICE processes but is significantly shorter and less detailed than in DM SPICE. In case DM SPICE is applied SUP.11 can be descoped.

Annex C.2 Interface to the Information Security Management Systems (ISMS) standard ISO 27001

This section describes the interfaces of Data Management SPICE and ISO 27001. Both frameworks ensure that data confidentiality, integrity, and availability are maintained while supporting operational efficiency and compliance.

Key intersections

Data Management SPICE establishes structured data governance, helping to ensure well-defined processes, while ISO 27001 mandates security policies to manage risks. By integrating governance and security policies, i.e. applying both frameworks, organizations can maintain consistency and compliance for their data.

Risk management and data lifecycle alignment is another important aspect, as Data Management SPICE addresses data-related risks throughout its lifecycle, and ISO 27001 applies a risk-based approach to information security. Together, both frameworks help mitigate risks across the data life cycle.

Access control measures align well, with Data Management SPICE managing data governance and ISO 27001 defining strict authentication and authorization mechanisms. Applying these frameworks, organizations can reduce the risk of unauthorized access and enhance data security.

For data quality, protection, and security, Data Management SPICE focuses tracking compliance to regulatory constraints, while ISO 27001 emphasizes information confidentiality, integrity, and availability. Aligning these frameworks helps organizations improve operational reliability and trust in data-driven decision-making.

Compliance and monitoring play a vital role, with Data Management SPICE supporting adherence to data-related regulations, while ISO 27001 mandates compliance with security regulations. Aligning compliance efforts helps organizations achieve a structured approach to governance and security.

Integrating both frameworks, organizations can enhance data governance, strengthen security, and ensure regulatory compliance, resulting in improved risk management and operational efficiency.

	ISO 27001	Data Management SPICE	Integration Approach
Focus	Information security (CIA principles)	Data governance, quality, and usability	Secure and high-quality data management
Risk Management	Minimizes security breaches and losses	Enhances data value and operational efficiency	Ensures both data security and data quality are managed together
Adherence and conformance to regulations	Security standards and regulations	Data-related regulations (e.g., GDPR)	Ensuring data security compliance alongside data governance frameworks
Risk Framework	Security risk management	Maturity improvement of data processes	Integrated risk management that ensures secure and reliable data
Model Type	Audit	Assessment	
Applicability	Organization	Organizational Unit	
Benefit	Excellence, regulatory compliance	Maturity & Excellence, regulatory compliance	

Table 3: Comparing Data Management SPICE and ISO 27001

Summary of comparing ISO 27001 and DM SPICE

ISO 27001 (and TISAX) is designed to evaluate and improve the processes that govern how Information Security Management Systems are planned, delivered, supported, and improved across an organization, not just within a single project. Data Management SPICE, however, is typically applied to any kind of organizational unit, in practice often focusing on processes related to a single project.

DM SPICE ensures that data quality and data governance is maintained across the data life cycle, whereas ISO27001 ensures confidentiality, integrity, and availability (CIA) of any kind of information assets.

Annex C.3 Interface to the Cybersecurity Engineering Standard for Road Vehicles ISO/SAE 21434

The relationship between Data Management (DM) SPICE and ISO/SAE 21434 lies in their shared focus on data governance, data security, and risk management. While DM SPICE is designed to reduce risks related to data quality, data governance and data management, ISO 21434 applies cybersecurity principles to automotive electrical and electronic (E/E) systems and their risks. The integration of these frameworks can help to ensure better cybersecurity resilience in data-driven automotive environments.

ISO/SAE 21434 ensures secure data handling within automotive electrical/electronic (E/E) systems by preventing unauthorized access and tampering. In parallel, DM SPICE focuses on managing the data lifecycle and data quality, defining governance practices, and ensuring compliance with regulatory constraints. The two frameworks can be combined by integrating DM SPICE's structured data management and governance practices across the data life cycle into ISO 21434 to enhance data security in connected vehicle systems.

For risk management, ISO/SAE 21434 leverages Threat Analysis and Risk Assessment (TARA) to identify, evaluate, and mitigate cybersecurity risks in automotive systems. On the other hand, DM SPICE provides practices based on ISO/IEC 33000 to assess process capabilities related to data management. DM SPICE's assessment and data quality practices can support and improve ISO 21434's TARA processes, enabling more effective data-driven risk decisions.

With respect to data quality and integrity, ISO/SAE 21434 ensures the integrity of cybersecurity-related data using for instance cryptographic verification methods and secure over-the-air (OTA) updates. Data Management SPICE focuses on maintaining and improving data quality based on criteria like accuracy, consistency, and reliability throughout the data lifecycle, from data extraction to data deployment. By combining both approaches, ISO 21434 can adopt DM SPICE practices to validate the quality and integrity of e.g., cybersecurity logs, event data, and diagnostic information in vehicles.

ISO/SAE 21434 supports compliance with regulatory standards such as UN R155 and ISO/IEC 27001 for vehicle cybersecurity. Meanwhile, DM SPICE supports broader data management compliance beyond automotive applications, including protection/privacy laws like General Data Protection Regulation (GDPR) and ISO/IEC 27001. The frameworks can be integrated so that ISO 21434 audits benefit from the structured and documented data management approach defined by DM SPICE, enhancing the traceability and robustness of cybersecurity audits.

The automotive cybersecurity standard ISO/SAE 21434 outlines procedures for detecting, reporting, and responding to cybersecurity incidents and vulnerabilities in automotive systems. DM SPICE establishes strategies for detecting and handling data breaches, focusing on incident logging and response mechanisms. Integrating both frameworks enables shared intelligence and a coordinated response to automotive cybersecurity incidents, particularly those involving sensitive data in connected vehicles.

	ISO/SAE 21434	Data Management SPICE	Integration Approach
Data Governance & Security	Ensures secure data handling within automotive E/E systems, preventing unauthorized access.	Manages data lifecycle, governance policies, and compliance with data protection and security regulations.	ISO 21434 can integrate DM SPICE principles for structured data security in connected vehicle systems.
Risk Management	Threat Analysis & Risk Assessment (TARA) for cybersecurity risks in automotive systems.	ISO/IEC 33000-based risk frameworks for data management practice.	DM SPICE's process capability assessments can support ISO 21434's TARA processes by improving data-driven decision-making.
Data Quality & Integrity	Ensures data integrity in cybersecurity (e.g., cryptographic verification, secure updates).	Defines and improves data quality criteria like accuracy, consistency, and reliability.	ISO 21434 can apply DM SPICE methods to validate the integrity of cybersecurity logs, event data, and vehicle diagnostic information.
Adherence and conformance to regulations	Ensures compliance with UN R155 (Cybersecurity for Vehicles) and ISO/IEC 27001.	Supports regulatory compliance (e.g., GDPR, ISO/IEC 27001).	ISO 21434 audits can leverage DM SPICE's data management structure for cybersecurity-related audits.
Incident & Vulnerability Management	Specifies cybersecurity incident response and vulnerability management for automotive systems.	Defines operational handling and monitoring for detection, logging, and response strategies for data breaches.	Both frameworks can be integrated for shared intelligence on cybersecurity incidents affecting data assets in connected vehicles.
Model Type	Audit	Assessment	
Applicability	Organization/Project	Organizational unit	
Benefit	Cybersecurity risk management, regulatory compliance	Process maturity & excellence, regulatory compliance	

Table 4: Comparing Data Management SPICE and ISO/SAE 21434

Summary of comparing ISO/SAE 21434 and DM SPICE

ISO 21434 is designed to evaluate and improve the processes that govern how cybersecurity is planned, delivered, supported, and improved across an organization and within projects managed in that organization. Data Management SPICE focuses on processes related managing data and data quality of an organizational unit.

Annex C.4 Interfaces to IT service management standards SPICE for IT-Services, ITIL, ISO 20000

Data Management SPICE focuses on managing the entire lifecycle of data within an organizational unit, ensuring that data is handled effectively and efficiently to support business processes. Its primary objectives include:

- Data Governance: Establishing policies, procedures, and responsibilities to manage data as a valuable resource.
- Data Quality: Ensuring that data is accurate, complete, and reliable for use in decision-making and operations.
- Data Management: Managing core data to provide a consistent and uniform view within the organizational unit.
- Governance: Identifying and managing regulatory constraints on managing data across its life cycle; e.g., standards related to data protection or security.

Focus of SPICE for IT-Services

SPICE for IT-Services is centered on delivering and managing IT services to meet the needs of the business. It aligns with frameworks like ITIL (Information Technology Infrastructure Library) and ISO/IEC 20000, focusing on:

- Service Delivery: Ensuring that IT services are delivered efficiently and effectively to support business operations.
- Incident Management: Resolving service disruptions quickly to minimize impact on business operations.
- Service Level Management: Agreeing on and managing service levels to meet business requirements.
- Change Management: Managing changes to IT services in a controlled manner to minimize risks and impacts.
- Continuous Improvement: Continuously improving IT service processes to enhance service quality and efficiency.

ITIL provides a comprehensive framework of best practices for IT service management, while **ISO/IEC 20000-1:2018** offers an international standard for IT service management, ensuring that organizations adhere to best practices and achieve certification for their service management systems.

All IT service management standards do cover business aspects, e.g., represented by content for service portfolio and service catalogue management, business relationship management, and the overall scope of the service management system.

The definition of the term service in ISO/IEC 20000 shows that it is not limited to technical IT services. So, it can cover a much broader service scope than just IT/digital services.

Together, these frameworks ensure that IT services are managed in a way that supports business goals, maintains high levels of service quality, and adapts to changing business needs.

	SPICE for IT-Services	Data Management SPICE	Integration Approach
Focus	IT Service & Infrastructure Management	Data life cycle management & governance, data quality	Ensuring data quality within IT services
Typical Processes	Incident management, service level management, change management	Data governance, data quality, master data management	Data-driven service optimization
Application Area	IT service providers, IT departments within companies	Data-driven organizational units (e.g., automotive, banking)	IT service management in data-heavy environments (e.g., cloud, big data services)
Key Stakeholders	IT service managers, helpdesk teams, infrastructure teams	Data stewards/owners, data analysts, operations specialists, data quality responsibles	Cross-functional teams managing data for IT service continuity
Certification Relevance	Aligned with ISO 20000-1:2018	Often internal assessment, ISO 30000 compliant	Ensuring IT services comply with data quality standards
Related Frameworks	ITIL, ISO 20000, COBIT, CMMI® with service domain.	ISO 8000, DAMA-DMBOK, GDPR, HIPAA[3], CMMI® with data domain	Best practices ensuring data compliance in IT services
Model Type	Assessment	Assessment	Assessments combining processes from both SPICE models.
Applicability	Organizational unit	Organizational unit (typically a project)	Organizational unit (typically a product/service line)
Benefit	Process maturity & excellence, regulatory compliance	Process maturity & excellence, regulatory compliance	Process maturity & excellence, regulatory compliance

Table 5: Comparing Data Management SPICE and SPICE for IT-Services

Summary of comparing SPICE for IT-Services and DM SPICE

In the landscape of modern, digital, service-driven business, IT Service Management and Data Management are two fundamental but distinct disciplines, each with its own focus and objectives.

IT Service Management focuses on the delivery and support of IT services. Its primary goal is to ensure that IT services are reliable, efficient, and continuously aligned with business needs.

Data management, on the other hand, focuses on the lifecycle of data, including its collection, storage, governance, and use. It aims to ensure data quality and data governance, enabling organizations to leverage data as a strategic asset for informed decision-making and their digital services business.

A digital service can be seen as a technical combination of three main components:

[3] HIPAA, Health Insurance Portability and Accountability Act, is a U.S. federal law to protect patients' medical information and privacy.

- IT infrastructure (e.g., software and hardware capabilities or infrastructure),
- Connectivity (e.g., to the Internet through a telecommunications provider), and
- Data (i.e. the content of a service).

While SPICE for IT-Services helps organizations manage digital services as a whole, including a management system according to the ISO 20000-1 standard, Data Management SPICE helps address the specific challenges and opportunities associated with data.

Organizations delivering data-driven services can benefit from understanding the focus areas of each discipline and using both PAM, SPICE for IT Services and Data Management SPICE to foster a more integrated and responsive operating environment.

Annex D – Data Management SPICE guideline regarding the role of senior management

A typical discussion in any assessment or improvement initiative aiming at anchoring processes on project level is the role and impact of organizational and management constraints.

A key to achieve and rate any process attributes and capability levels is to understand that even though the scope is a project, the larger picture has a direct impact on how the work can be performed and how people behave as well as how the underlying culture is reflected on what we see on the surface.

It is a key responsibility of executives and senior management to set clear objectives, ensure the necessary support and sponsorship as well as to show clear commitments. If any of this is not performed well, higher level ratings are difficult or even impossible to achieve.

It becomes more crucial when it comes to any change and transition. Expectations must be expressed clearly and backed up with sufficient funding and resources. Fulfilment and progress should be monitored constantly, and corrective actions have to be initiated and performed if necessary.

That aspect doesn't change in a data related environment. It becomes especially evident in assessments, when ratings are negatively impacted by resources or training not being available, by gaps in communication, by unachievable objectives, by lack of trust in the team, by lack of decision-making authority, by constantly changing internal objectives and structures, etc... So many – if not most – of the weaknesses identified can be traced back to inconsistent behavior of management functions and lack of governance mechanisms within an organization.

As part of any improvement of or transition to data management practices you should consider the following aspects

- Any directives or policies within the organization will impact the behavior on team and on individual level. **Please ensure that those management expectations are clearly phrased and communicated and actively used to link improvement objectives for data management with organizational objectives**.
- Any of those management expectations should be reflected on team (of teams) or project level in, e.g., **strategies, objectives, and governance criteria and recorded as such.**
- The success of any product is based on the availability and right skill set of the people performing the work. **Please ensure that the allocation of resources (people and infrastructure and tools) is made transparent and based on traceable priorities**.
- In practice this implies that a team does not plan based on not assigned resources; a sure indicator is the NN (not named yet) for team member slots. Note that it is not required to provide unlimited resources to the project, but **that the planning is based on realistic assumptions and active risk management and traceable decision making**.
- Often, a lack of interest in process-oriented work at middle management leads to inconsistent and incomplete implementation of good practices in teams. **Please ensure active interest in process-oriented work and support for conformance to agreed on governance criteria**, e.g., based on existing directives/policies/standards/regulatory requirements.
- People are often demotivated by lack of respect and recognition towards their contributions for process improvement. **Please ensure that clear sponsorship for improvement is in place to make the change happen. That includes assigning authority and holding people accountable to achieve objectives.**