# P&IDs Digitizing
## brownfield sites

**Practical Guide for Operators, Engineers, and Technical Decision Makers**

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# Executive Summary

In many existing plants, P&IDs are available but no longer fulfill their intended function to a significant extent. As static PDFs, they are neither consistent nor analyzable and are increasingly evolving from master documents into operational risks. Modifications, audits, and digitization initiatives become unnecessarily complex due to the lack of reliable, up-to-date plant data.

Attempts to solve this problem by completely recreating all P&IDs typically fail in brownfield environments due to the effort, costs, and lack of expertise involved. A realistic approach therefore focuses primarily on usability: converting existing PDFs automatically into structured, machine-readable P&IDs.

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**This white paper shows how plant operators and engineering managers can implement such a pragmatic approach.** It describes the technical requirements, typical pitfalls and a proven approach for the step-by-step digitization of existing flow diagrams—as the foundation for data-centric engineering, consistent plant operation, and future automation and AI applications.

# Starting Point:
## *When P&IDs and flow diagrams go from being a master document to a risk*

**P&IDs and flow diagrams are the central reference document for a plant. They describe the process, define safety-related equipment, and form the basis for permits, modifications, as well as operation and maintenance. In theory, they are the "single source of truth" for all disciplines involved.**

However in the practice for many brownfield plants, this ideal has been lost since long. The majority of P&IDs and flow diagrams are available as PDFs & are often from different project phases, planning systems, or archived versions. Changes incorporated are either manually updated over the years—or not at all

The problem here is not that this information is missing. What is far more critical is that these flow diagrams can no longer be relied upon.

**Typical consequences in everyday practice:**

- Discrepancies between documentation and the actual plant condition ("As-planned" vs. "As-built")
- High coordination effort required for maintenance and retrofits
- Uncertainty in safety assessments
- Reliance on individuals with experiential knowledge

As long as a plant is operated without changes, this shortcoming often remains hidden. However, it becomes a structural risk at the latest during expansions, audits, or digitalization projects. Because one thing is clear: PDFs provide images, but no reliable data.

# Why traditional digitization approaches don’t work in brownfield environments

Given this situation, the solution seems obvious: The P&IDs and flow diagrams are completely remodeled, neatly structured, and rebuilt as “as-built” documentation.
However, this very approach is the most common reason why digitization projects in brownfield environments fail.

**There are clear reasons for this:**

### DISPROPORTIONATE EFFORT

Recreating the flow diagrams requires significant engineering resources. For large plants with hundreds or thousands of flow diagrams, the economic benefits are hardly conceivable.

### LIMITED AVAILABILITY OF KNOWLEDGE

Much of the detailed information no longer exists in a structured form.
It is locked in the experiential knowledge of experts—or has already been lost.

### HIGH PROJECT RISKS

The greater the manual component, the higher the risk of inconsistencies, misinterpretations, and deviations from the actual plant condition.

**The result is a familiar pattern: ambitious goals, pilot projects that aren’t scaled up, and ultimately a return to “enhanced PDFs.” The drive to create a perfect model blocks the path to a usable one.**

**A successful digitalization approach in brownfield projects accepts this reality. It does not aim for completeness at any cost, but rather for measurable, incremental benefits.**

# The realistic goal:
## *Intelligent P&IDs instead of perfect drawings*

**An intelligent P&ID is not a graphic discipline.
It is a structured plant model that links geometry, engineering data, and logical relationships.**

**What is crucial here is what this target vision does not have to be:**

- ▶ Not a complete reconstruction of all flow diagrams
- ▶ Not a seamless as-built model down to the last detail
- ▶ Not a one-time documentation project

**The goal is a functional, consistent P&ID that:**

- ▶ Clearly identifies and structurally maps piping
- ▶ Makes components and equipment available as data objects
- ▶ Keeps changes traceable and consistent

**Such a model improves decision making in engineering and operations without having to immediately resolve every historical ambiguity. It creates a robust database that can be further developed.**

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# The pragmatic approach:
## *Making smart use of existing PDF P&IDs*

A cost-effective digitization approach starts where most of the existing data is already available: - in vector-based PDF flow charts. The key is not only to visualize this data, but to analyze it in a structured way and convert it into a database-driven model.

### Such an approach must meet four fundamental requirements:

1. **Automation:** Large document collections must be processable with reasonable effort.
2. **Traceability:** Every step of the digitization process must remain verifiable.
3. **Scalability:** The approach must work for individual flowcharts as for entire systems.
4. **Controllability:** Experts retain technical control over the results.

### This is exactly where CADISON R25 comes in:

**Vector-based PDF P&Is are automatically imported, transferred with geometrical accuracy, and gradually converted into intelligent P&Is.**

Text, labels and markings are recognized via Optical Character Recognition (OCR) and stored in a structured format. Machine learning mechanisms identify component and equipment symbols and convert them into linked database objects. Piping and line markings are interpreted, pipelines are automatically created, and relevant attributes are assigned.

It is important to note that automation does not replace technical review; rather, it shifts the engineering effort from manual recreation to targeted verification and quality assurance.

# Visible, step-by-step digitization

In safety-critical brownfield facilities, transparency is mandatory. Automated digitization without clear visualization breeds mistrust among operations, engineering, and regulatory authorities and blocks project progress.

An effective strategy therefore relies on visible, step-by-step digitization. Color coding in the flow diagram directly shows:

- which content is already available as digital objects
- which still originate from the original PDF geometry
- which components have already been assigned to pipelines

## The benefits are tangible:

**a.** **Targeted post-processing of critical areas**

**b.** **Structured quality checks for approvals and audits**

**c.** **Clear project management, even with extensive document collections**

Without this visibility, automated P&ID digitization is virtually impossible to implement: engineers, safety officers, and plant managers refuse acceptance, and the project timeline is significantly extended. Transparency thus becomes a governance tool that ensures control, trust, and progress.

# Added value beyond P&ID:
## *Foundation for data-centric engineering*

Intelligent P&IDs only reveal their full value beyond the flowchart. Structured, consistent data forms the foundation for data-centric engineering, where changes automatically take effect across all relevant views. This increases efficiency, reduces errors, and strengthens collaboration across disciplines.

### Those who continue to rely on PDFs pay the price:

- Inconsistent changes
- Lack of reliable documentation for operations and audits
- Unclear responsibilities during modifications

Furthermore, standardized, harmonized plant models are a prerequisite for digital twins, simulations, and AI applications. Anyone planning such initiatives today without structuring P&ID data is wasting time and budget.

**The economic leverage is clear: Consistent data structuring can reduce engineering effort by 20 to 40%, while simultaneously improving data quality for operations and safety. Intelligent P&IDs are thus not only a tool for better drawings, but a strategic asset for efficient, low-risk plant operations and future-proof digitalization.**

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