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UPGRADING THE IMPACT APPLICATION FOR ENHANCED RISK DECLARATION AND APPROVAL PROCESSES AT CERN

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Abstract

The declaration and approval of activities related to CERN's accelerator complex are critical for ensuring safety and compliance. For the past 12 years, the Intervention Management Planning and Coordination Tool (IMPACT) has been the primary system facilitating these processes, enabling approvals by domain and location experts. However, evolving requirements and advancements in technology have necessitated a significant upgrade. This paper introduces the new system, which represents a migration from the legacy IMPACT application. It preserves historical data while offering key usability improvements, especially for mobile platforms. The updated system simplifies user interactions with clearer workflows and interfaces, reducing complexity for those declaring or approving activities. The development process prioritized a user-centric approach, incorporating iterative testing with stakeholders to ensure the system meets the operational needs of CERN's diverse activities. This paper outlines the technical architecture of the new system, strategies for data migration, and mechanisms designed to improve safety communication. This initiative aligns IMPACT with the integrated engineering platform developed by the Engineering Department (EN) and contributes to CERN's overarching goal of advancing safety standards through robust digital solutions.

INTRODUCTION

Interventions on the European Organization for Nuclear Research (CERN)'s accelerator complex require rigorous adherence to safety protocols. Central to enforcing these protocols is IMPACT, a web-based application launched in 2011, which issues access permits for work activities and gathers safety documents requested prior an intervention. It manages around 15,000 intervention requests annually (Fig. 1), ensuring safe, coordinated activities [1].

Integrated with the Access Distribution and Management System [2] (ADaMS), the system controlling physical access to buildings and accelerator areas, IMPACT typically mandates prior approval for underground access.

To address the significant technical and usability debt, CERN initiated a comprehensive upgrade of IMPACT [3].

Led by the Information Management (IM) group in the EN department and developed in close collaboration with Intervention Management Steering Board (IMSB), the upgrade of IMPACT was driven by the increasing difficulty in maintaining the legacy application and the need to align with the technology stack adopted by IM. This strategic modernization reinforces CERN's commitment to operational excellence and safety.

IMPACT was originally launched with a single type of document, the Activity, used to declare an intervention, confirm its scheduling, and grant access to the declared participants during the scheduled period. A variety of safety forms that were previously filled manually and uploaded to the Engineering and Equipment Data Management System (EDMS) [4] and Electronic Document Handling (EDH) [5] were ported to IMPACT, resulting in new safety documents linked to the Activity: fire permit declarations (FP), alarm disablement and recommissioning (IS37), inspection visits (VIC), electrical and cryogenic equipment lockout, notifications of electrical and water cuts (Note de Coupure). Complex planning and follow-up features for radiological protection were implemented with the Radioactive Environment Intervention File (DIMR) and Work Dose Planning (WDP) documents [6, 7], and linked to the Activity.

In 2017 a lightweight mobile-friendly frontend was released offering only core functionalities but adoption remained low due to usability issues.

PROJECT GOALS

In 2021, a joint analysis by the Business Computing (FAP-BC) and IM groups identified key areas for improvement through technical evaluations and user interviews.

The conclusions led the foundation for the new IMPACT project aiming to ensure long-term sustainability, minimize disruption, and eliminate security risks by migrating to modern infrastructure and fully transferring historical data. To maintain user familiarity, established workflows should largely be preserved, while removing underused features. Integration with external systems should continue, with targeted improvements to interoperability with EN tools and enhanced User Interface (UI) transparency.

The project also aimed to transfer service support responsibility from FAP-BC to IM, aligning the development with key stakeholders. Implementation began in early 2022, and the service responsibility was successfully transferred in October 2024.

PROJECT DELIVERY

As individuals and responsibilities evolved over time, the core owners of the various features were first re-identified. The Activity document proved especially challenging because of the many stakeholders and their varied needs. The "as is" status was documented and validated with the owners. The possible improvements were identified and prioritized

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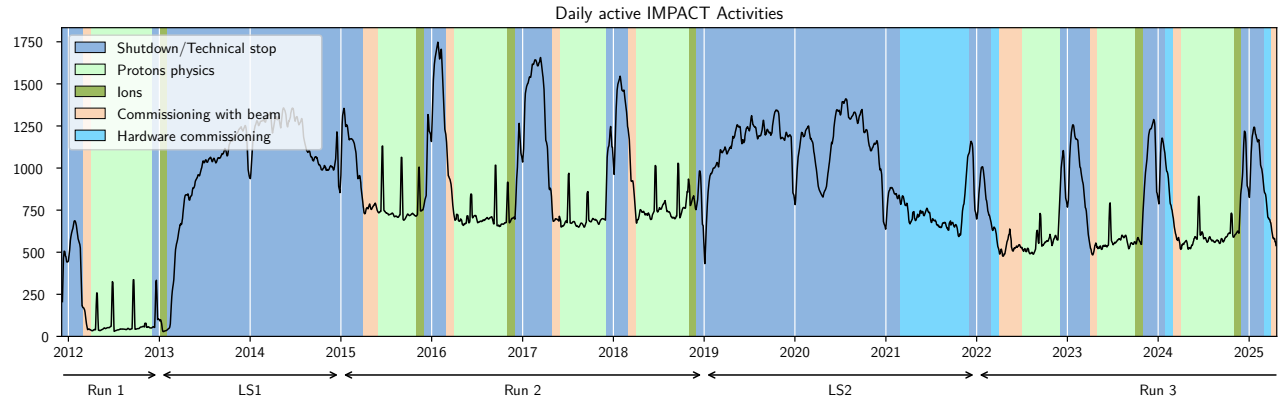

Figure 1: Number of ongoing activities on a given day, overlaid with the LHC schedule [8].

against the existing features. Further improvements that were not compatible with the project deadlines were kept in the backlog. The development followed an Agile [9] two-week sprint. Key stakeholders were invited to the fortnightly sprint review, during which the latest developments were demonstrated. Periodic reports to the IMSB guaranteed global alignment with CERN's priorities.

Several strategies were evaluated for both deploying the new system and decommissioning the legacy application. A "Big Bang" migration—switching systems in a single operation–was ruled out due to the scale and mission-critical nature of the platform. Instead, a phased approach was adopted, allowing both systems to operate concurrently. Application pages were gradually migrated to the new system. To streamline maintenance and enhance user experience, each page was made available on only one system at a time. A redirection mechanism ensured users were automatically routed to the appropriate version.

Features were migrated as complete vertical slices, each resembling a self-contained mini-application with its own data, domain logic, integrations, BPMNs, and UI. Typically, each slice corresponded to a single safety document. When documents were tightly coupled, they were migrated together. Each release encompassed the following tasks: creation of entities in the new database and their configuration in the object-relational mapping (ORM); implementation of BPMN processes; development of backend services encapsulating the domain logic; exposure of REST APIs; creation of corresponding UI pages in the new frontend; decommissioning of legacy application pages with appropriate redirection logic; and execution of migration procedures for data and BPMN processes.

This approach enabled a staged rollout from May 2023 until mid 2025, with minimal disruptions for the users and manageable support work for the developer team. Additionally, the software foundation could be validated early on in production with a small set of functionalities, before being generalized to the rest of the application, reducing project risks and maximizing the early learning, in line with Agile principles.

BUSINESS PROCESS MODELING NOTATION (BPMN)

IMPACT relies on Business Process Modeling Notation (BPMN) to formally represent and execute complex domain logic (Fig. 2). The Activity process was also modeled in BPMN, reducing system complexity while enhancing transparency and consistency for users. The execution history is conserved and can be used to produce useful metrics and insights (Fig. 3).

BPMN models, represented as XML files created with graphical modeling tools, serve dual purposes: they act both as graphical documentation of processes and as executable artifacts run by a dedicated engine. The Camunda BPMN engine was chosen for the runtime execution. As an ISO standard with broad tooling support, BPMN provides a structured language to capture domain logic, including explicit modeling of failure scenarios [10]. These features allow implicit domain knowledge to be made explicit and validated collaboratively with domain experts [11]. In addition to the standard implementation of the BPMN features, Camunda offers a rich cockpit that visualizes the execution of the processes (current and historical). This has proved valuable during deployments and operational support.

The development process involved a thorough review of the legacy BPMNs, with domain experts engaged in multiple validation sessions. This participatory approach uncovered opportunities for refinement—for example, adding a specific step for selecting alarms to be disabled in the IS37 document. BPMN models can be versioned and updated independently of application code. New versions can either coexist with old ones or replace them, with the latter requiring migration of running instances. Furthermore, BPMN processes can be unit tested to avoid regressions and are fully auditable, providing detailed histories that reveal decision paths—an insight that would be challenging to extract if the logic were embedded in Java code with database-backed state.

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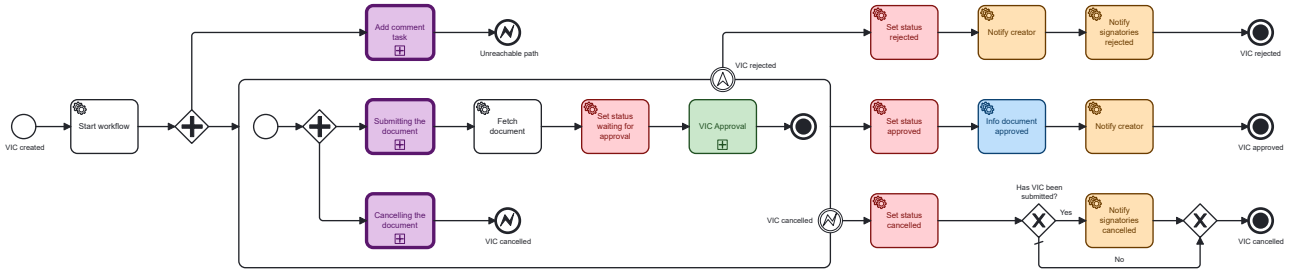

Figure 2: The BPMN process that models the Joint Inspection Visit (VIC) document (Visite d'Inspection Commune). The main flow follows a horizontal axis. Activities are color-coded for clarity: purple (tasks), red (status changes), green (signatures), blue (information), yellow (notifications), and white (external tasks).

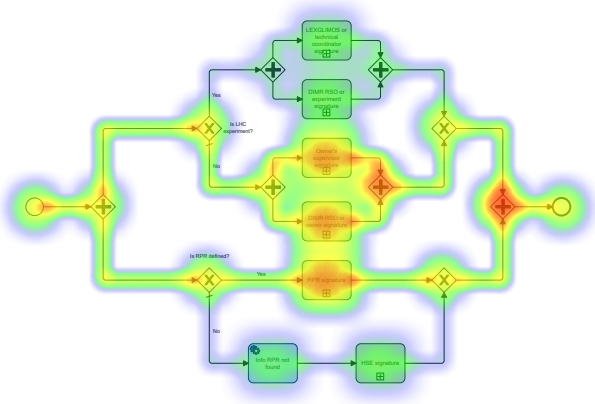

Figure 3: The BPMN process for DIMR approvals documents satisfying the As Low As Reasonably Achievable (ALARA) level 2 condition. It is overlaid with a heatmap highlighting the areas most frequently traversed.

Task-Based Domain Logic and User Experience

Tasks are the core elements of new IMPACT's BPMN models, linking domain logic with end users. They are central in both process execution and the UI, reflecting the domain model at a level aligned with expert understanding.

IMPACT processes capture two behaviors: engine-driven automation and user-driven interaction. Engine-driven tasks execute logic such as conditional approvals or timed reminders. User-driven tasks involve direct actions like approvals or data entry, within a context defined by the BPMN model.

Each task defines who is responsible (individuals, CERN roles, or user pools), why (based on domain-specific logic), what is expected (e.g., disable alarms), and when (deadlines or timeouts). The engine manages the task lifecycle—opening, completing, or terminating tasks based on process state. For example, canceling a document closes all related edit tasks.

Tasks are co-designed with domain experts, explicitly represented in BPMN diagrams, and surfaced in the UI through structured lists. This avoids duplicating logic in the interface—for instance, modeling edit rights via tasks directly.

IMPACT's implementation added key features: escalation based on CERN roles, flexible delegation without extra process complexity, clear responsibility tracking, and automatic routing of execution failures to support teams.

Backend and BPMN Integration

Business processes define the decision-making logic and the order of orchestration but do not contain the implementation of the logic itself. The actual logic is executed by services located in the backend. Communication between the process engine and the backend primarily follows three mechanisms.

First, top-level processes are typically instantiated by the backend via a *start event*, which includes the provision of initial variables. Second, the process can trigger *external tasks*, which represent calls from the process to the backend. These tasks result in jobs being enqueued and asynchronously processed by the backend. Inputs and outputs may be exchanged during this interaction. Third, although less frequently used, the backend may send a *message event* to the process. This allows the backend to inform the process, provided that a matching message listener is active.

IMPACT AS A PLATFORM

While the new IMPACT currently addresses primarily safety-related activities and access control, its underlying architecture is designed for broader applicability. The platform integrates with core CERN systems, including HR, Roles, Locations, Equipment, Access Control, and Radiation Protection. It provides robust support for implementing and enforcing domain-specific logic, expressing it through standardized CERN-wide roles. Additionally, the system facilitates structured data collection via custom web forms and manages approvals and notifications within various workflows. Formal modeling and explicit execution of processes, currently relying heavily on implicit organizational knowledge, could significantly enhance reliability and traceability, clearly address error conditions, reduce dependency on informal communication and ad-hoc decisions, and lower costs associated with personnel turnover.

These comprehensive capabilities position the new IMPACT platform as a critical milestone towards the broader vision of an integrated engineering platform at CERN [12].

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