TECHNICAL ARTICLE

# Modular vs. Field-Built Process Plants

Choosing the right execution strategy for re-refining plants, process sections, revamps and brownfield upgrades.

BALAJI CONSULTANTS | KNOWLEDGE CENTRE

CORE SPECIALISATION: USED-OIL RE-REFINING

# Execution strategy should support the process

Modularisation and field construction are different ways of delivering a plant—not different process technologies.

*A used-oil re-refining plant may be delivered as a predominantly field-built facility, as one or more preassembled process modules, or through a hybrid execution strategy combining both.*

The process technology should be frozen first. Only then should the engineering team determine which sections are best modularised and which are better fabricated or erected at site.

### Balaji positioning

Modularisation is an execution strategy, not a standalone core technology. Balaji Consultants applies it particularly to selected used-oil re-refining sections, WFE systems, solvent-recovery packages, finishing systems and brownfield revamps where off-site integration offers a practical advantage.

# Preassembled process sections with defined battery limits

Equipment, structure, piping and selected instrumentation are integrated before dispatch.

In a modular configuration, equipment is mounted on structural skids or modules together with piping, valves, instruments, supports and selected electrical or control components.

## Typical modular candidates

- WFE / TFE systems
- Solvent-recovery units
- Pumping and filtration skids
- Chemical dosing systems
- Vacuum packages
- Condensation systems
- Regenerative polishing sections
- Utility packages

### Modularisation begins during design

Transport size, module weight, lifting points, centre of gravity, battery limits, pipe breaks and site tie-ins must be considered before detailed engineering is frozen.

# Maximum site integration for large or widely distributed equipment

Field-built plants are assembled predominantly at the final project location.

Large vessels, columns, storage tanks, structural platforms, pipe racks and long-distance interconnecting piping are often more practical to install individually at site.

## Field-built execution is often preferred when

- Equipment dimensions exceed practical transport limits
- Long pipe racks connect widely separated process areas
- Local fabrication capability is strong
- Large tank farms dominate the facility
- The plant layout must fit tightly around existing equipment
- Transport of large modules would be uneconomic

### Field-built does not mean less engineering

A field-built project still requires disciplined 3D modelling, layouts, isometrics, support design, material control and construction planning.

# The principal execution differences

| Factor | Modular / Skid-Mounted | Field-Built |
|---|---|---|
| Schedule | Shop fabrication can proceed in parallel with civil work. | More sequential dependence on foundations, erection and field piping. |
| Site labour | Lower field welding and fabrication requirement. | Higher site labour and supervision requirement. |
| Quality control | More work completed in a controlled fabrication environment. | Quality depends more strongly on site conditions and contractor discipline. |
| Transport | Module dimensions and weight can be a major constraint. | Individual equipment is generally easier to transport. |
| Site congestion | Reduced field activity can simplify brownfield work. | More trades work simultaneously in the process area. |
| Design freeze | Requires earlier interface and layout freeze. | Allows somewhat greater field adjustment. |
| Testing | More preassembly and factory checks before shipment. | Mechanical and functional testing concentrated at site. |
| Shutdown exposure | Can reduce tie-in and installation duration. | More work may need to occur during shutdown. |

# Where modular execution can create the greatest value

Short shutdown windows and congested operating sites often favour off-site fabrication.

Brownfield re-refining projects frequently involve existing tanks, vessels, heaters, vacuum systems, structures and utilities that must remain in service until a planned shutdown.

## Typical revamp applications

- Existing batch plant + WFE retrofit
- Additional WFE capacity
- Vacuum-system upgrades
- Condensation packages
- Solvent-recovery additions
- Regenerative clay-polishing upgrades
- Pumping and transfer systems
- Automation and control packages

### Battery limits are critical

Every process, utility, vent, drain, electrical and instrument connection must be surveyed and frozen accurately before a brownfield module is fabricated.

# A natural application for selective modularisation

Existing batch dehydration can be retained while continuous WFE recovery is added downstream.

In a semi-continuous revamp, the existing dehydration and degassing section may remain in batch service. Conditioned oil is transferred to buffer storage and then pumped through a preheater into one or more continuously operating WFEs.

## Sections well suited to modular execution

- Feed pumping and preheating skid
- Condenser and receiver package
- Residue-handling skid
- WFE module
- Vacuum package
- Local instrumentation and control interfaces

### Why modularisation helps

The new WFE section can be substantially fabricated, piped and checked before the shutdown. Site work is then concentrated on foundations, module setting and defined tie-ins to the existing plant.

# Compare total installed cost—not fabrication price alone

The cheapest equipment supply route is not always the lowest-cost project.

## Modular cost elements

- Structural skid or module frame
- Route survey
- Off-site piping and assembly
- Pre-dispatch testing
- Transport bracing
- Heavy lifting
- Factory inspection
- Module transportation

## Field-built cost elements

- Site labour
- Construction supervision
- Scaffolding
- Rework
- Temporary facilities
- Field welding
- Site productivity losses
- Longer installation duration

### Shutdown economics can dominate

For a running plant, a more expensive module may still be commercially superior if it reduces production downtime or allows the majority of work to be completed before the shutdown.

# The practical limit to modularisation

A module provides no advantage if it cannot reach the site safely and economically.

## The logistics study should review

- Road width and turning radius
- Port restrictions
- Module weight
- Crane capacity
- Customs / cross-border handling
- Bridge capacity
- Module dimensions
- Trailer availability
- Site access
- Lifting and setting sequence

### Design around the transport route

Maximum module dimensions should be established before the structural and piping layout is frozen. Late module splitting can create unnecessary field work and compromise the original modular strategy.

# Factory integration can reduce field uncertainty

Preassembly allows dimensional, mechanical and selected functional checks before shipment.

## Activities that can be completed before dispatch

- Dimensional verification
- Piping fit-up
- Instrument installation
- Dry functional checks
- Equipment alignment
- Pressure testing
- Panel inspection
- Factory acceptance checks

This is particularly valuable for high-vacuum systems and WFE packages, where equipment alignment, piping geometry, vacuum integrity and condensation arrangement materially influence plant performance.

### Factory checks do not replace site commissioning

Final utility integration, control-loop testing, hydrocarbon commissioning and performance verification still take place at site. Preassembly simply moves more risk resolution earlier in the project.

# Often the optimum solution for complete plants

Large plants rarely need to be entirely modular or entirely field-built.

| Plant Section | Typical Strategy | Reason |
|---|---|---|
| Storage tanks | Usually field-built. | Large diameter and site-specific layout. |
| WFE / vacuum systems | Strong modular candidates. | Compact, technically sensitive process packages. |
| Large columns | Case-by-case. | Transport and erection constraints often favour loose shipment. |
| Pipe racks | Mostly field-built or structural modules. | Distributed across the plot. |
| Control panels / MCC rooms | Can be modular. | Reduces site integration work. |
| Utilities | Case-by-case. | Depends on capacity and distribution distance. |

### Selective modularisation is usually better than forced modularisation

The objective is to modularise the sections where factory integration improves schedule, quality or shutdown management, while field-building equipment that is naturally site-specific.

# Questions to answer before freezing the execution philosophy

- Is the project greenfield or brownfield?
- Which equipment exceeds transport limits?
- What shutdown window is available?
- What are local site labour rates?
- What sections are technically sensitive?
- What cranes and transport routes are available?
- Could the process section be relocated later?
- What is the plant capacity?
- How congested is the site?
- How strong is local fabrication capability?
- Can shop work proceed in parallel with civil construction?
- How many battery-limit connections are required?
- Is future expansion expected?
- What level of pre-dispatch testing adds value?

### Execution method should follow process and project risk

The decision should consider total installed cost, schedule, construction risk, shutdown exposure, quality control and future flexibility—not merely whether a skid looks convenient.

# Build the plant in the way that best protects process performance

*Modular and field-built construction are alternative execution strategies. Neither is inherently superior. The correct approach depends on the process, equipment size, logistics, site conditions and project objectives.*

For used-oil re-refining, modularisation is especially effective for compact WFE systems, vacuum packages, solvent-recovery units and selected brownfield revamps. Large tanks, columns, pipe racks and widely distributed plant infrastructure are often more practical to field-build.

### For many projects, hybrid execution is the optimum

Field-build what is large and site-specific. Modularise the technically intensive process sections where off-site integration adds measurable value.

Balaji Consultants develops the execution philosophy together with the process design. Our focus remains used-oil re-refining technology and plant performance; modularisation is applied where it improves fabrication control, site schedule, revamp integration or shutdown management.