PICKING UP THE PIECES

Utilizing DISASTER RECOVERY PROJECT MANAGEMENT to improve readiness and response time.

BY PHILLIP E. HAYES & AUBREY HAMMONS

AS IT CROSSED THE ATLANTIC OCEAN, Tropical Storm Georges grew and on 17 September 1998 became a full-fledged hurricane that would build to a Category 4 storm at its strongest. Hurricane Georges crossed the Caribbean Sea and the Gulf of Mexico, wreaking destruction on the U.S. Virgin Islands, Puerto Rico, the Dominican Republic, Haiti, Cuba, and the Florida Keys, before finally hitting the U.S. Gulf Coast. Georges was responsible for approximately 500 deaths and over US$5 billion in damages. Fig. 1 shows the path of the destructive hurricane. On 28 September 1998, the hurricane hit land at Biloxi, Mississippi, USA, as a Category 2 storm with 105-mph sustained winds with gusts measured at up to 175 mph. There, the storm stalled for over 17 hours, pounding the area with its 12-foot storm surge, while dumping 16.68 in of rain [1]. Fig. 2 gives an indication of the size of the hurricane and the area affected as Georges stalled upon striking land.

When Hurricane Georges hit the Florida Keys, deflecting its course and putting Pascagoula, Mississippi, USA within its potential path, the local refinery implemented standard hurricane readiness plans. A shutdown of the refinery was initiated when the storm's forecasted path

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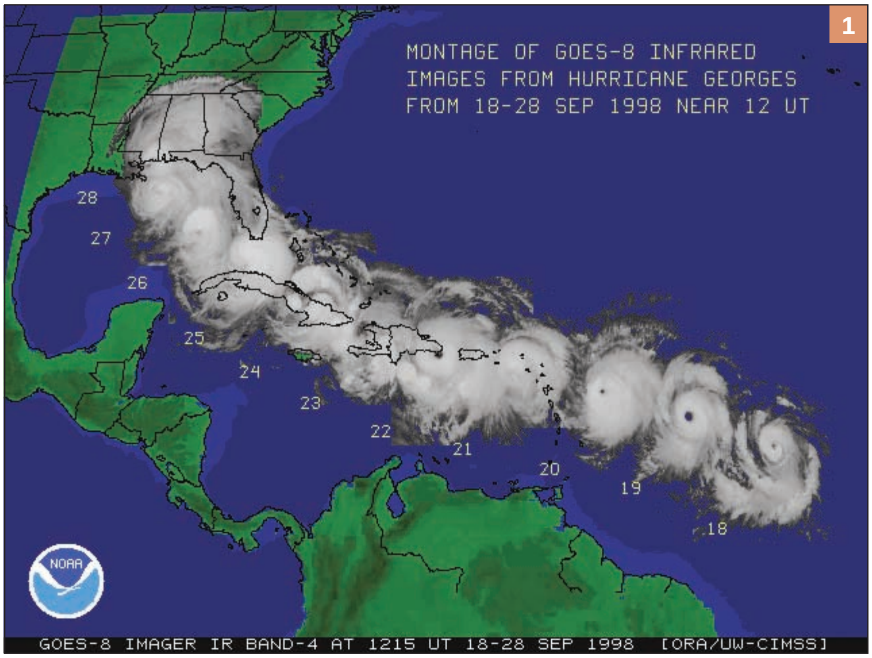


Hurricane Georges' path of destruction left 500 dead and US$5 billion in damages in its wake.

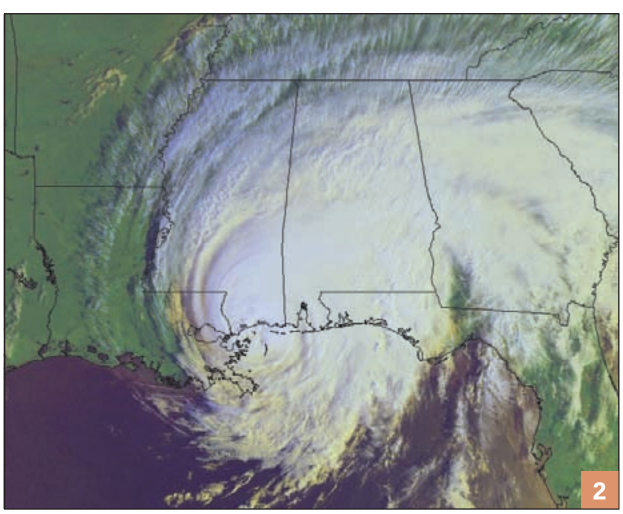
changed from landfall at the mouth of the Mississippi River to landfall to the east along the Mississippi Gulf Coast. All processes were brought to a halt, and the entire refinery was brought to a stop. Key critical equipment was removed and relocated to safe storage on high ground far from the refinery and the coastal area. Refinery vehicles and mobile equipment were moved to high ground within the refinery. Power was shut down to all but critical areas, including the administration building, where the 33-member ride-out crew would monitor the refinery throughout the disaster. The storm confined the ride-out crew to the building's second story Emergency Response Center, where they remained isolated for the next 72 hours.

The refinery is located directly on Mississippi's coast, with only a half mile of salt-water marsh separating the refinery from the Gulf's intercoastal waterway. The refinery's planners had foreseen the threat hurricanes could pose for the facility, surrounding the facility with 9-ft dikes. Unfortunately, this protection was overcome by the 12-ft storm surge, flooding the refinery in over 5 ft of seawater. The onslaught of wind and waves damaged, and even physically moved, several building and product tanks. The four primary buildings, including facility maintenance, were flooded in up to 64 in of salt water. All ground-level equipment was submerged, with wave action reaching some equipment at higher levels. High-speed winds stripped insulation from piping, damaged or removed building roofs, and inflicted significant damage to the facilities' cooling towers.

While the seawater was quick to overcome the refinery's defenses, it was slow in leaving. Fig. 3 shows the refineries tank farm still under water days after Hurricane Georges' departure. The flood waters took the next three days to drain sufficiently to allow refinery personnel to re-enter the facility. The destruction and disruption was almost overwhelming.

The next week was spent in an effort to access the scope of the damage and develop a strategy to recover from the disaster. Since nothing of this magnitude had ever been experienced, all existing planning was insufficient to undertake such a task.

It was immediately apparent that this was a major undertaking, and extensive teaming would be required. Alliance partnerships were determined to be the optimum solution, as such key factors as pricing, specification, and business relationships were already developed, understood, and reliable. This history would allow refinery personnel and management to address global issues, such as reliability, project scope and direction, and prioritization. Alliance partners could be relied upon to execute recovery in their areas of expertise, addressing technical requirements, project management, logistics, process development and execution, and documentation.



The storm stalled, pounding the area with its 12-ft storm surge and dumping 16.68 in of rain in 17 hours.

Development of the Recovery Plan

Facing the Disaster

The first task upon re-entering the refinery was to determine the extent of the disaster. Due to the very short notice allowed by the storm's change of path, very little vital equipment could be moved to safe elevations. All ground-level equipment still within the refinery was submerged in up to 5 ft of salt water. Of the refinery's 600 roofed structures, 400 sustained wind or water damage. Over 48,000 square feet of administrative office space, all operations control centers, and maintenance shops were flooded. Five-hundred desks, 2,000 office chairs, 1,600 file cabinets and bookcases, 150 computers, and 45 printers were lost. The majority of the refinery's vehicles were destroyed, including 49 pick-up trucks, eight larger trucks, 12 passenger cars/vans, a bus, two mini groves, five forklifts, four diesel generator/welders, and 11 of the plant protection vehicles, counting two fire trucks and an ambulance. See Tables 1 and 2 for summaries of affected industrial equipment and the scope of the damage and servicing. Once the scope of the damage was known, an effective plan of action could be defined. Field audit teams were assembled, consisting of refinery personnel from engineering, maintenance, and operations, to survey the damage. Refinery management soon determined that the damage far exceeded the resources of any single source. Their solution was to supplement their team by bringing in key business partners and contractors with resources to provide support in their areas of expertise. Ultimately, if refinery personnel could bring their knowledge of the refinery and its operations and team with these partners who provide product technical and commercial expertise and manufacturing resources, the recovery process could be optimized and safely and successfully executed.

Scope of Work

The refinery management team was faced with limited space and facilities within the refinery, so the partners and contractors who would be brought in to assist had to be the right ones. It was critical that each group bring the optimum return, providing the proper resources to as broad a range of needs as possible, while maintaining world class expertise in their areas of capability. Therefore, an engineering constructor was chosen to work under refinery personnel supervision for the removal and handling of damaged equipment. Then an alliance partner who specializes in that type of equipment would address individual requirements. Once equipment was ready to be re-installed, the engineering constructor would again work with refinery personnel to put the equipment back into operation. In each area, refinery personnel would team with the partner or contractor to assure proper priorities were communicated both to refinery management and to partner company resources.

Establishing Priorities

Tables 1 and 2 include equipment needed to operate such fundamental equipment as water, fire control, and sewage facilities; building HVAC systems; and facility machine tools. Obviously, the physical plant systems were first priority to safely work. Refinery maintenance personnel had routinely reconditioned much of the mechanical equipment. This made the refinery's maintenance facility a high priority in the recovery, as much of the damaged equipment could then be quickly and effectively handled on site.

Once these fundamentals were addressed, the principal task of bringing the refinery's operating plants back online could begin. The magnitude of the recovery dictated that a systematic approach be implemented. The logistics of an undertaking of this size balancing manpower, manageability of the project, and limited space, required that the refinery process be evaluated to determine the best path forward. Since product flows through the refinery from the dock or pipeline, through the crude unit, the various plants and subprocesses within the refinery, and, finally, to the shipping and blending area, a logical order of progress and priority naturally existed. The recovery of individual plants could be planned in close sequence, with teams working in parallel to execute a cascading turnaround within the refinery. A prioritization team, consisting of refinery management, the products group, refinery operations, engineering, and maintenance was needed. This

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The 12-ft storm surge quickly overcame the refinery's 9-ft levies, flooding the facility in up to 5 ft of seawater in the office building, units, and tank farm alike.

TABLE 1. SUMMARY OF DAMAGE AND SERVICING OF AFFECTED HEAVY INDUSTRIAL EQUIPMENT

Affected Heavy Equipment		*Total Existing*	*Total Damaged*	*Repaired On Site*	*Repaired Off Site*	*Replaced*
Mechanical	Gas Turbines	2	2	0	2	0
	Centrifugal Compressors	26	5	0	5	0
	Pumps	2,100	1,900	1,100	800	0
	Turbines	305	280	130	150	0
	Gearboxes	450	100	0	100	0
Electrical	Substations	31	31	25	0	7
	Motors	3,000	2,300	0	900	1,400

group could then take information from partners and contractors to develop an all-inclusive project recovery plan and schedule, maintaining safety, manageability, and reliability, with minimum down time. The team could continuously modify and compensate for contingencies that would arise throughout the recovery process, identifying bottlenecks and critical paths. Necessary resources could then be brought to the needed area and avoid wasted effort in other noncritical areas.

Equipment Reliability

Long-term reliability and lowest total cost of ownership is always of utmost concern. The recovery effort had to take all efforts to not only bring the refinery back up to operation as soon as possible, but to assure long-term reliability, striving for predisaster levels. Not only is the re-energizing of electrical equipment extremely dangerous if not properly addressed, but flooding is very detrimental to the performance and reliability of mechanical and electrical equipment. The corrosive and contamination properties of salt water made this flood extremely detrimental [2]. All equipment had to be decontaminated and desalinated before reconditioning could begin [3]. Desalination is particularly important to electrical insulation systems, where salt and other seawater contaminants will continue to precipitate into the insulation and degrade the effectiveness over time [4]. Strict methodology had to be implemented to properly recondition the flooded equipment [5]-[7]. In addition to the desalination, it was important to maintain the refinery's repair standards and specifications, including documentation requirements for future operations.

Economic Considerations

All these technical reliability factors had to first be evaluated in terms of cost for reconditioning versus replacement cost. Obviously, equipment would be replaced if the new purchase cost were lower than that associated with reconditioning the existing equipment. Reliability and technology improvements are in addition to cost savings. Therefore, one of the initial tasks was to determine guidelines for replace versus recondition for standard off-the-shelf type equipment. This guideline was based on the minimum required recondition cost versus the replacement price. Then, the condition of equipment whose replacement cost was beyond this guideline would be evaluated. This total estimated recondition cost must then be evaluated relative to replacement cost. However, as is found with larger, engineered, or specialty-type equipment, lead times may far exceed the recondition time. The new equipment delivery cycle must be weighed against the priority within the recovery schedule and existing critical paths within that time line. Each day the refinery was down resulted in large financial losses due to lost production. Therefore, an analysis must be made, weighing the cost associated with the delay in schedule against higher cost to recondition and deficiency in reliability and technology advancement. Hence, communication between the refinery management team, alliance partners, and contractors proved to be the most critical area within the recovery effort.

Execution of the Recovery Plan

Recovery Process

Once the scope of the work was defined, the business partner was responsible for turning around the equipment within their scope. Disasters pose a unique challenge in many ways. The type and extent of damage that can occur varies greatly. The planning and tools in place, and the degree to which they apply, also covers a broad range. Damage of this extent was virtually unprecedented, so there were very few applicable processes established. The procedures, business mechanics, data management, and technical skill set definition then developed or modified to meet the needs of the recovery. The following outlines a model that was highly effective in addressing the broad spectrum of needs present in disaster recovery. This example was duplicated by multiple partners in the recovery, applying it to

TABLE 2. SUMMARY OF DAMAGE AND SERVICING OF AFFECTED LIGHT INDUSTRIAL EQUIPMENT

Affected Light Equipment	*Components Repaired/Replaced*
Electrical	Electrical heat tracing: approximately 15 mi replaced/repaired
	Wire pulls: approximately 57 mi replaced
	Breakers/motor starters: approximately 500 repaired/replaced
	Motor control centers: 48 repaired, 8 replaced
	Motor start/stop stations: approximately 2,000 replaced
Instrumentation	Approximately 12,000 instrumentation items repaired or replaced. This included 3,000 process control valves and 500 emergency shut-off valves. This required the replacement of 6,200 valve accessories, such as positioners, regulators, solenoids, relays, etc.
	Approximately 9,000 pieces of instrumentation. This included flow, pressure, temperatures, level transmitters, alarms, etc.
	15 analyzers replaced
	35 sample systems replaced

mechanical and electrical equipment successfully. While circumstances vary, this methodology proved highly effective in the recovery effort.

Replace Versus Recondition Guideline

The first step was to determine replace versus recondition guidelines. Refinery reliability engineering worked with the insurance companies to determine the lines of demarcation with input from the business partner. Typical reconditioning requirements were defined and the cost of these repairs estimated for a range of ratings. Recondition costs were compared to the replacement cost for standard off-the-shelf equipment. See Fig. 4 for a representation of the basic relationship between the cost of reconditioning versus replacement.

A final consideration in determining the recondition versus replacement guideline was motor service shop capacity. The law of supply and demand dictates the number and associated capacity of motor repair shops. As a result, the motor repair shops remaining today have limited excess capacity. It was important to use the existing capacity for motors, which could not be readily obtained in the short turnaround needed during the recovery.

Replacement Equipment

The ideal model would call for each piece of equipment to be identified and a replacement purchased to the refinery's technical specifications, brought on site, documented, and arrive on site as the damaged equipment is removed. With the replace/recondition guideline established, new replacement equipment could be purchased as soon as identified. Today, industry has typically matched production capabilities to normal market demand and implemented just-in-time inventory methodologies. Due to the size of the refinery, the magnitude of replacements required would quickly deplete stock inventories. To avoid major delays in the latter portion of the recovery, equipment needs had to be determined as early as possible, so that the equipment could be ordered ahead of the need.

Equipment Information

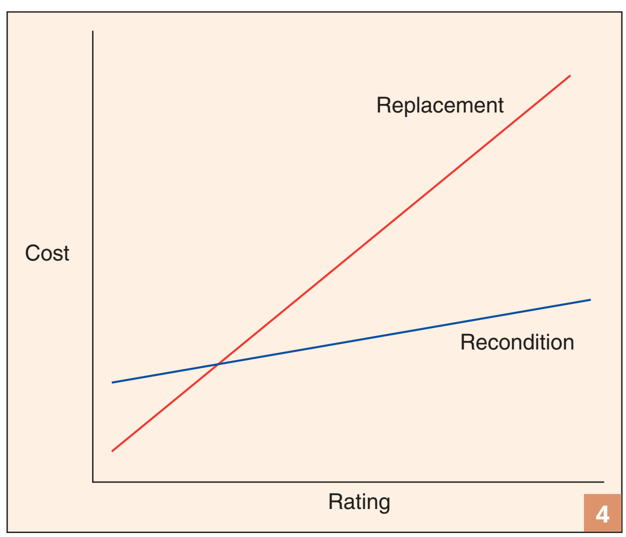
Records are kept of all refinery equipment from the time the equipment is purchased and installed. These documents would identify the equipment and define replacement requirements. This database of information could be used to place the equipment order based on the priority team's scheduling. All efforts are made during the day-to-day activities in the refinery to document equipment changes. The database is updated with pertinent information every time a modification or repair necessitates changes in the equipment. One of the values the alliance partners were able to bring to the recovery effort was detailed knowledge of the information required to specify equipment that would successfully replace the damaged equipment. It was soon discovered that, as good as the refinery's records were, refinery expertise is not suited to the needs of new equipment replacement. In some cases, as little as half the equipment documentation was accurate or complete enough to use for order placement. Very few cases where modifications had occurred included all the necessary dimensions and tolerances required. While ratings changes were noted, questions often remained if changes had occurred to other criteria typically affected by the type of changes noted.

In many cases, where service and/or installation had been performed by outside parties, entire modifications were not documented at all. Some equipment, such as electromechanical machines, were routinely addressed by multiple groups within the refinery: mechanical, electrical, reliability, etc. These changes may have been documented within their own database, but not the others. Referencing multiple database information often resulted in more confusion. The presence of a complete and accurate database was critical to minimizing down time and turn around. Without this accurate equipment information, it was necessary to physically inspect each and every piece of equipment to be replaced. With a significant amount of the equipment, critical information could not be obtained with it in place. Refinery management determined that this type of equipment would best be addressed once it was pulled from its installation. Since resources and even the physical space in which to maneuver was limited, equipment often had to sit for weeks before the priority warranted allocating resources to it's removal. If a complete and accurate database had been available, those weeks could have been taken directly from the delivery cycle, directly reducing its down time. Not only would this produce savings by reducing production losses, but new and more technologically advanced equipment could have been installed, increasing reliability, reducing total cost of ownership, and sometimes even providing more features and increasing usability.

Process Methodology

Overview

Once the state of the equipment information had been evaluated, the process methodology could be effectively developed. Equipment would be pulled from its installation and brought to the appropriate partner's operations. The partner would then determine and execute recondition



The relationship between the cost of reconditioning electric motors versus replacing them.

or replacement requirements and properly document these actions. The refinery needed to record all activity for accounting purposes and wished to populate a complete and accurate database with all necessary information and actions taken on each piece of equipment for reliability matrix and troubleshooting during future refinery operations. Each business partner had to develop and implement business mechanics and systems to execute this process. In addition, since the process was a live and evolving one, complete flexibility had to be incorporated into the system to meet possible future needs that could develop as the recovery took place.

Priorities and Process Requirements

Each business partner was faced with the challenge of adapting or developing the process needed to execute an effective recovery in the minimum time cycle while maintaining long-term reliability. With the overall project requirements defined, a process with the necessary flexibility and adaptability had to be conceptualized and documented. Process logic and decision points had to be identified. Documentation of the process and the actions taken for each piece of equipment would be required for accounting purposes.

As the refinery management identified necessary changes, the business partners were sometimes required to modify the business mechanics or process. Unique conditions would be identified and the process changed to accommodate these and similar circumstances that could arise. As a result, communications within the business partner's operation, as well as between the refinery management team and the alliance partner, had to be clearly defined, documented, and updated as the recovery evolved. Efforts were continuously made to improve the process and learn throughout recovery. As priorities changed, resource requirements would grow and change. Operations, the process, the resources, and individuals involved were changed as these needs changed. These changes did have to be made with care, however, as they could be very disruptive. This became particularly evident in the establishment of priorities. As with other large refineries, multiple products are normally manufactured at the facility, utilizing various subprocesses and additives. The actual end products to be produced will dictate the equipment needed for operations. The refinery management's normal mode of operations is to produce various products based on the current and projected demand and market value. The refinery's typical response time is very quick relative to recovery planning. Therefore, it was found that the products to be manufactured had to be prioritized and, once established, held with relatively firm resolve. If these priorities were allowed to change frequently, excessive efforts would be lost as equipment requirements changed, making earlier work no longer on critical demand and placing previously low-priority equipment on critical path. See Fig. 5 for a graphic representation of the resulting process model.

Model Process

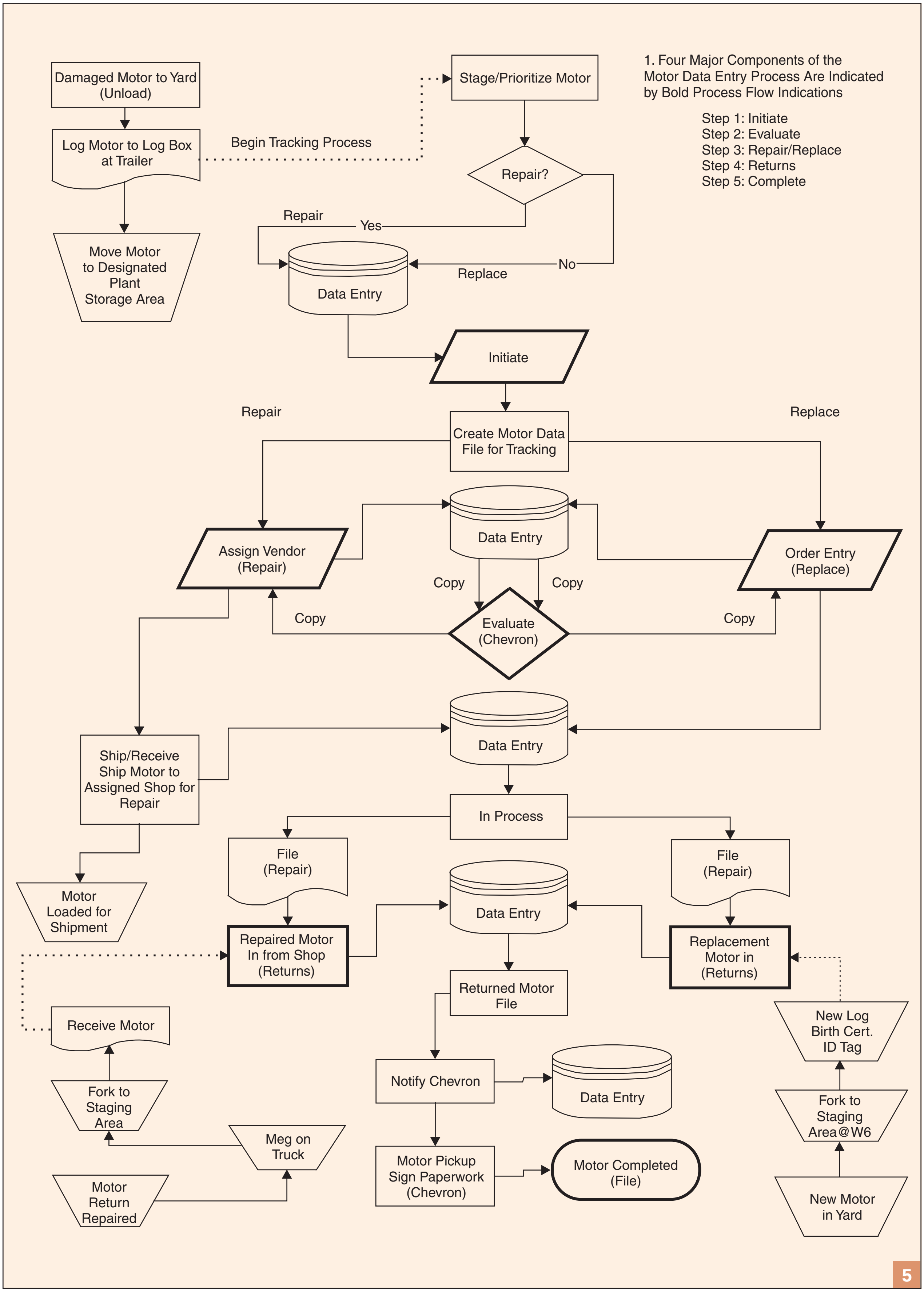
Business partner team responsibility began upon receiving the equipment from the refinery constructor team. Partner personnel with technical expertise would then document and evaluate the equipment. First, it was determined whether it was standard, specialty and proprietary, or engineered equipment. Unfortunately, the data nameplates from many manufacturers did not contain all the information necessary to specify replacements. Governing organizations cannot define designations for optional or special features. Each piece of equipment was inspected for options, nonstandard features, and modifications. In facilities of this age or older, care has to be taken to determine that the equipment does indeed conform in all areas to current industry standards.

If it was determined to be standard type equipment, all detailed information necessary to purchase its replacement was recorded. If deviations were discovered, they were analyzed to determine if a current standard product could be used or minor modifications could economically be made to standard products to fit the application. If so, this information was recorded. If either standard products or modified equipment were possible, the documentation was forwarded to the new product team members who were responsible for purchasing; modifications and adapters, etc.; scheduled delivery; and documentation.

If the equipment was determined to be specialty/proprietary, the original equipment manufacturer (OEM) supplier was contacted to obtain best possible deliveries. If delivery was possible by the priority teams need date, replacement equipment was ordered. Damaged equipment that was to be replaced would be set aside in a holding area to be available if needed. The damaged equipment would sometimes be needed for accessories that had been overlooked, could not readily be replaced, or if some engineering question arose during the recovery. The damaged equipment could also be utilized if there was a problem in obtaining the replacement, meeting the schedule, another piece of equipment failed, or priorities changed, making the original scheduled delivery unacceptable.

If the equipment was specifically engineered for an application, a specialty/proprietary piece of equipment whose delivery or replacement cost was outside project criteria or standard type equipment that had been highly modified or unable to match with modern standards would have to be reconditioned.

The challenges in properly reconditioning equipment were many. Technical expertise in properly decontaminating and desalinating the equipment was foremost for personnel safety and in providing long-term refinery reliability in the years following the recovery. Service facilities also had to maintain the refinery's usually high standards by complying with the normal specifications and documentation needed for operations, maintenance, and troubleshooting once the refinery returned to normal operations. Due to the standing alliance partnership the refinery had established, their specifications, documentation, and methodologies requirements were well known and could be applied immediately. As with new equipment manufacturing, service shops have capacity limitations as well, so to meet the huge demand brought on by the disaster, independent repair shops were pursued. The alliance partner was responsible for the quality of all work performed during the recovery, so an extensive training



An example of part of the complex process of recovery.

and audit process was established to ensure all subcontracted repair shops met all technical, specification, and documentation requirements. Alliance partner resources were dedicated full time to performing audits, including unscheduled inspections, throughout the recovery process to ensure each shop was adhering to all technical procedures and the quality was maintained. This subcontracting increased resources, minimized time for transporting the equipment, and helped keep turnaround time to a minimum.

There were many considerations in coordinating equipment recondition. The condition of equipment within any refinery will vary depending on the age, application, criticality to the process, its normal maintenance, and the original design. Therefore, it was necessary to evaluate each piece of equipment to determine its unique requirements. As each service shop has physical plant space, equipment size, and process-capability constraints, some equipment could not be properly handled at all facilities. The required scope of repair for each piece of equipment had to be evaluated in regard to shop loading, capabilities, timeliness, and geographical location to successfully satisfy the priority team's need date.

Since equipment condition varied, more than normal reconditioning was often required. If possible, the refinery's spare parts were used. Not all equipment had spare parts, or fewer spares were kept for multiple machines, as it is normally unlikely that all will go down simultaneously. The age of the equipment is a factor in how extensive the damage caused by the disaster and the degree of repair required. Problems found that may have been caused or aggravated by the disaster or were pre-existing required special attention. Many of these additional conditions required reliability and economic decisions to be made by the refinery and the insurance companies. This communication between parties was critical and had to be managed very proactively to minimize the delays.

Once equipment was back from the service shop, or a new replacement was received, all the documentation was gathered, tagged, and filed for that equipment identification number. The equipment itself was tagged for identification and correlation to the documentation. Then, the re-installation of the equipment was coordinated with the engineering constructor teams.

Information Communication

Due to the large magnitude, complexity, and compressed schedule of the disaster recovery, there were many variables constantly changing. Hence, the planned courses of action, each being interrelated and interdependent, were under continuous review and revision.

The partner business project manager worked in conjunction with the refinery's management and priority teams to continuously evaluate equipment priorities. Each equipment team had to communicate status back to the refinery management so that the effects on schedule and critical path changes could be determined. To evaluate the effects of all the various equipment within the refinery, a wide variety of data was needed in various formats. See Table 3 for an array of project management data requirements and Fig. 6 for a sample status report. Communicating this data across the recovery allowed each team to concentrate on critical equipment, shifting focus as needed to optimize resources. Effort on equipment on a particular line within a plant would be wasted if another key component were subject to a major unplanned delay. Therefore, it was key to have knowledgeable operations personnel within each team. When a piece of equipment became critical, that expertise was used to determine other affected process equipment, so that resources could be applied to the most immediate needs.

Human nature being as it is, individuals responsible for establishing priorities within an individual plant or process would tend to view all equipment as vital to the operation, preferring to err on the conservative side. This operations expertise was vital in establishing true priority and equipment's criticality. It was not unusual to find nonsafety back-up equipment identified as highest priority. The partner team's operations personnel could discuss equipment such as this with that process's management and personnel to determine the true priority and need date. The same methodology was often applied when a conflict in resources or deliveries varied. Often, it was found that some equipment was used for supplemental processes, not the core process scheduled, allowing proper allocation of the immediate resource to the core process, keeping the project on target.

TABLE 3. PROJECT MANAGEMENT DATA REQUIREMENTS

Motor Recovery Status	All motors by plant per stage.
Motor Priority Table	By plant per stage.
Motor Special Requirements	Heater elements required motors with adapter bases. Special installation required.
Motor Repair Update	Total repair status: each service shop status in process motor update.
Motor Ready Summary	Replace/repair motors by plant. Special accessories required.
Motor Recovery Audits	Damaged motor inventory. Replace/repair in process. Field installation verify.

Database

Accurate and timely information proved to be the one of the most critical, and often one of the most rare, ingredients to a successful recovery. With accurate and up-to-date information, orders for replacement equipment could have been ordered immediately. If equipment history and previous repair information had been available, replacement parts could have been ordered and on hand before equipment teardown began. Machine-specific conditions and requirement information would assure proper handling and repairs without re-installation and testing.

When a disaster of any magnitude strikes, project management requirements for information are paramount. All equipment information available is needed in various formats, Seeing the data presented in different views enables the manager to see trends and areas where improvement is needed. This applies to status reports to refinery management as well. Various refinery managers have different priorities and concerns that drive the data that each needs to review. New areas of focus arise throughout the recovery, making new data required. Thus, it became quite clear early in the recovery that an electronic database and information management system was needed. All equipment information needed for replacing that equipment had to be gathered initially so that the order could be placed. This information, along with such purchase information as order date, delivery data, etc., was entered as well. This was cross-referenced to the priority database to establish allocation. As needs changed, the database was quickly referenced, and equipment could be re-allocated to meet these demands. When the initial equipment data was gathered to determine replacement or recondition, all necessary information was entered, regardless of the ultimate recovery action taken. As this equipment was sent out for reconditioning, the shop, service required, turnaround time, delays, etc., were entered into the database. This enabled the partner business project manager to monitor shop loading and performance to optimize resource utilization to best meet the recovery's needs. All this information to managers could be updated immediately and was distributed periodically, and, after computer communications throughout the refinery were re-established, the data was available online.

The database also provides the refinery with a complete database for future operations and plant turnarounds. All equipment history is captured as well as service shop performance. The database can be sorted as needed for equipment troubleshooting, and to see trends in equipment performance, brand, and vendors; service shop performance; etc. This will enable the refinery's reliability personnel to optimize resources in the future and realize the best return on investment.

Stage	Prior	Total Identified by Chevron	"Motors Initiated" Motors Brought to Rockwell Automation			"Motors at Evaluation" Determination of Path Forward			"Motors in Process" Motors Ordered or in Shops		"Motors Returned" Ready at Warehouse 6		"Motors Complete" Picked Up from Warehouse 6		Percent of Motors to Ready to Install
			Total	Replace	Repair	Chevron	Replace	Repair	Replace	Repair	Replace	Repair	Replace	Repair	
1	1	594	329	148	181	0	0	0	1	2	7	1	140	178	99%
	2	63	60	30	30	0	0	0	9	3	1	2	20	25	80%
	3	22	3	1	2	0	0	0	1	0	0	1	0	1	67%
2	1	845	470	268	202	0	0	0	6	3	9	5	253	194	98%
	2	190	132	85	46	1	0	0	22	13	2	1	61	32	73%
	3	52	18	10	6	0	2	0	5	6	0	0	5	0	28%
3	1	353	211	134	73	1	2	1	35	18	21	1	78	54	73%
	2	41	35	22	13	0	0	0	11	2	2	0	9	11	63%
	3	18	4	3	1	0	0	0	1	1	2	0	0	0	50%
4	1	647	368	215	124	6	23	0	111	58	8	6	96	60	46%
	2	209	110	46	57	0	7	0	19	45	2	0	25	12	35%
	3	703	87	58	28	0	1	0	22	11	0	1	36	16	61%
Total=		3,737 275 4,012	1,827	1,020	763	8	35	1	243	162	54	18	723	583	71%
				1,783			44		405		72		1,306		
				1,827					1,827						

Note * Number of Motors in Stock to Draw from = 116
* Total Identified by Chevron is Based on the Highest Priority for Each M Number, from Either Passport or Operations Lists. This is the Most Conservative Method to Resolve the Conflicting Data.
* Motors at Evaluation are in a Decision Process Which will Determine if to be Replaced or Repaired, Hence Account for the Deviation Between Total Initiated and the Replaced & Repair Initiated Summed.
# 275 Motors Without Prioritization.

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Clear, complete, and concise communications are critical to an effective recovery.

Recovery Results

As a result of the outstanding efforts of all involved with the recovery effort, the first phase for the refinery start-up was accomplished within 55 days of the hurricane. This phase was centered on the larger crude unit and represented approximately 65% for the refinery's total capacity. The second phase of the recovery was completed 30 days later, bringing virtually the entire refinery back up to full capacity by the first part of January 1999.

For practical purposes, there were no start-up problems with any of the various refinery process units. In fact, this was one of the best start-ups that the refinery has experienced. Not only did the start-up occur without incident, but the entire recovery was conducted without any lost time safety occurrence.

In the year following the recovery, all efforts to maintain the refinery's overall reliability have proven very successful. Of the over 900 motors reconditioned during the recovery, less than 1% have had subsequent failures.

As a true testament to the effectiveness of this type of teaming, all this was accomplished in considerably less time than originally anticipated.

Lessons Learned

Many lessons were learned throughout the recovery that can be used to better prepare for disasters such as Hurricane Georges. Many of these lessons are seen to have great value in normal operations and scheduled plant turnarounds as well. In the urgent and accelerated mode of a recovery, time is of the essence. It was very difficult for anyone not on site participating in the recovery to grasp the mode of operation. The effort and time demanded of the recovery personnel and support businesses is extreme. A day during the recovery was like a week in normal business operations, weeks were like months, and months like years. Any predisaster readiness pays back many fold during a recovery. An accurate, current, and complete database information management system with all the necessary data is vital. This information can be used to great advantage and savings throughout normal operations and plant maintenance turnarounds as well.

Due to the complexities of a recovery, priorities and recovery plan changes must be managed carefully. The changes mandated by unexpected and unpredictable events will be nearly overwhelming without changing plans of action during the process. Production priorities have to be set early on an overall benefit basis and not changed constantly on the fluctuation of the market. The recovery process is a re-iterative one, based on variables of multiple parallel paths and diverse technical expertise.

Another key point learned was that resolving conflicting directives, such as new equipment cycle time's reliability and lower cost-benefit versus reconditioning's immediate delivery's cost and potential reliability shortcomings requires refinery technical direction and insurance company consideration. This decision process must be very timely and is a potential bottleneck.

The time demands of the recovery are incredible. As mentioned, normal business cycles are compressed dramatically. Therefore, all parties must understand that it is critical to bring in additional resources immediately upon recognizing the need. Moving material and people takes time, and there are limits to how much the process can be expedited. This lesson applies directly to the primary objective of any group within the recovery: You do *not* want to be the critical path equipment at any time during a recovery!

Conclusion

Throughout the recovery, it seemed as if practically everything in the refinery was being reworked or replaced, and that was indeed the case for a large portion of it. Changes occurring in one area usually had an impact on other areas and often created a snowball affect. While change was inevitable, it was critical that it be minimized and managed carefully to keep the recovery on track for success. Product priority and, thus, plant and equipment priority must be thoughtfully established as soon as possible to minimize wasted effort and minimize turnaround time.

Communication between the refinery management team, alliance partners, and contractors proved to be the most critical area within the recovery effort. Anything that can be done to improve, expedite, and/or clarify communications is well worth the effort. Information is key to an effective and efficient recovery. The presence of a complete and accurate equipment technical data and history database was critical.

While every disaster is unique, the key points outlined in this article can be of great assistance identifying key areas in planning and executing a successful recovery.

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Phillip E. Hayes (phayes@teeco.net) is with Texas Electric Equipment in La Porte, Texas, USA. Aubrey Hammons is with Chevron Products Company in Pascagoula, Mississippi, USA. Hayes and Hammons are members of the IEEE.

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